Engineering News

VOLUME 72 SEPTEMBER 3, 1914 NUMBER 10

# Seros Power Development, Lerida, Spain: Diversion Dam and Canals

By J. C. Stevens*

*SYNOPSIS—The Seros Project, from which the Spanish city of Barcelona is to derive a supply of electricity, is of unusual interest from its 17 odd miles of supply canals, its long diversion dam, its four regulating reservoirs, its numerous control gates, its high-head power house, etc. The important features of diversion dam, canals, and gates are disclosed in this article, together with interesting notes on the construction work. The regulating reservoirs, earth dams and power house will be described in a subsequent article.*

The notable hydro-electric development described below is indicative of a great change in Spanish internal affairs, a few words on which are necessary to explain the reasons for such work as herein outlined.

One important cause of the disastrous effects of the internal dissentions and external invasions, which caused Spanish colonial power to slip away, has undoubtedly been the lack of attention to the development of natural resources. A large part of the Spanish population has been content with a hand-to-mouth existence and internal improvements have been extended to only moderate achievements. In recent years, however, relief from the burden of foreign possessions and foreign wars has given a great impetus to internal development. In Cataluna especially is this true. The backbone of national prosperity is agricultural development and nowhere is this more forcibly seen than in this district. Such advances have induced material advances in all other lines of activities; manufacturing industries have sprung up on all sides in a country where labor is yet comparatively cheap and raw materials plentiful.

Lower Concrete-Lined Canal; Seros Power Development, Lerida, Spain

Hence, the existing industries, the latent possibilities for further advance, the well developed agriculture, and all the attendant necessities for transportation and manufactured articles, render Cataluna a fruitful market for commercial power.

At almost the exact spot of one of Cæsar's important operations against Pompey (49 B.C.) is the work herein described. Cæsar found his enemies at Lerida on the banks of Rio Segre (called "Llerda" on the "Sicorio" in his *Commentaries*). During the 40 days' fight that fol-

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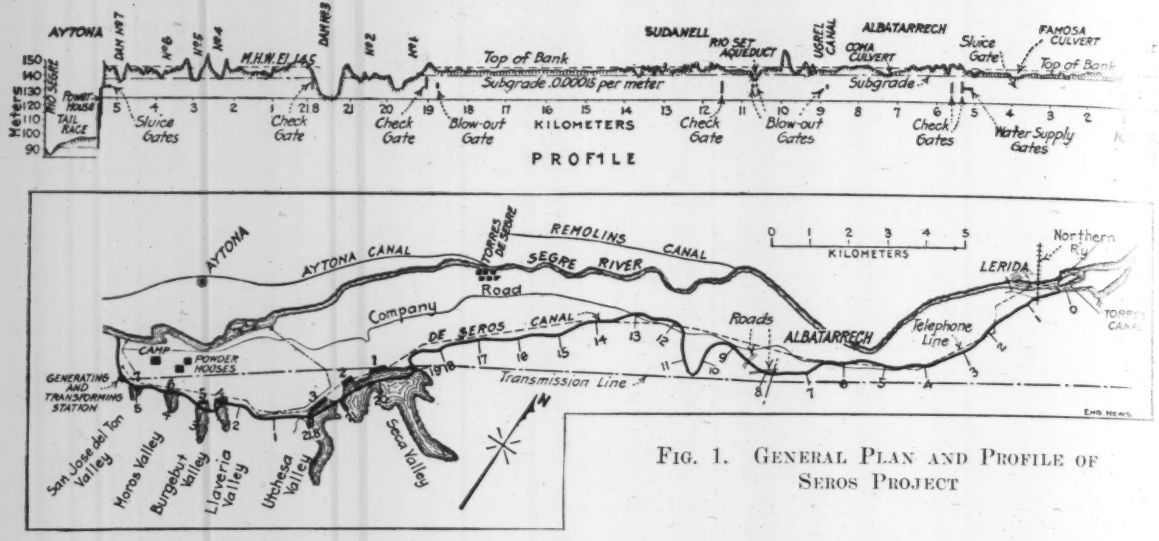


FIG. 1. GENERAL PLAN AND PROFILE OF SEROS PROJECT

lowed, Cæsar diverted the river into several channels, each 30 ft. wide, and so reduced the volume of water in the main river as to render it fordable for his cavalry. In this manner he surprised his enemies in their camps, completely routed them, and closed a campaign as remarkable for its brevity as for its success. Where Cæsar diverted this river, the modern engineer has done likewise but for the peaceful purpose, then unknown, of generating electricity.

This development is in the hands of the Barcelona Traction, Light & Power Co., through its subsidiary, the Ebro Irrigation & Power Co., Ltd., which has under way three hydro-electric projects on Rio Segre and its principal tributary, Rio Noguera Pallaresa; (1) The Gerri project; (2) the Talarn Dam and Pallaresa Canal; (3) the Seros project. The first was started as a 3000-hp. temporary plant for construction service but has become a 4000-hp. permanent station and has been in operation since February, 1913. Near Talarn, a concrete dam 86 m. (282 ft.) high will impound 210 million cubic meters (170,000 acre-ft.) in a river valley; at the dam is to be a power house and tail water carried 18 km. in canal to a second station. The Talarn dam was 10% completed on May 1, 1914. The Gerri and Talarn sites are adjacent and some 135 km. northwest of Barcelona; the Lerida project is 80 km. southwest of Gerri and 140 km. east of Barcelona. The power generated will be largely used in Barcelona and outlying districts. Transmission lines connect the two projects and from a mid-point branches the Barcelona line.

The present article (and the subsequent one) will deal solely with the Seros project which was completed in

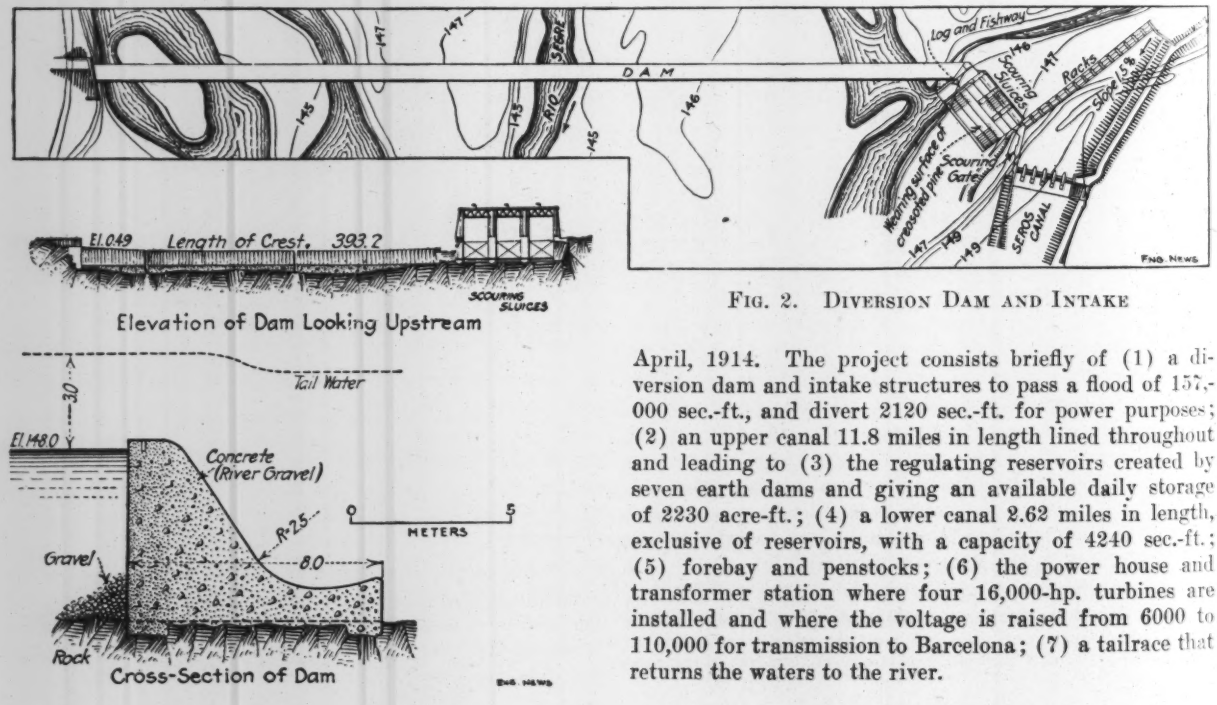


FIG. 2. DIVERSION DAM AND INTAKE

April, 1914. The project consists briefly of (1) a diversion dam and intake structures to pass a flood of 157,000 sec.-ft., and divert 2120 sec.-ft. for power purposes; (2) an upper canal 11.8 miles in length lined throughout and leading to (3) the regulating reservoirs created by seven earth dams and giving an available daily storage of 2230 acre-ft.; (4) a lower canal 2.62 miles in length, exclusive of reservoirs, with a capacity of 4240 sec.-ft.; (5) forebay and penstocks; (6) the power house and transformer station where four 16,000-hp. turbines are installed and where the voltage is raised from 6000 to 110,000 for transmission to Barcelona; (7) a tailrace that returns the waters to the river.

Fig. 1 is a general map of the Seros Project and a condensed profile of the power canal. The total length from diversion dam to tailrace is 28.4 km. (17.6 mi.). The total natural fall in the river between these points at low stage is 52 m. (170.6 ft.).

## Upper Canal

Headworks—The general arrangement of the dam, intake, racks, sluice gates and canal gates is shown in Fig. 2. As the river carries considerable gravel at time of flood, the three large sluice gates are placed in such

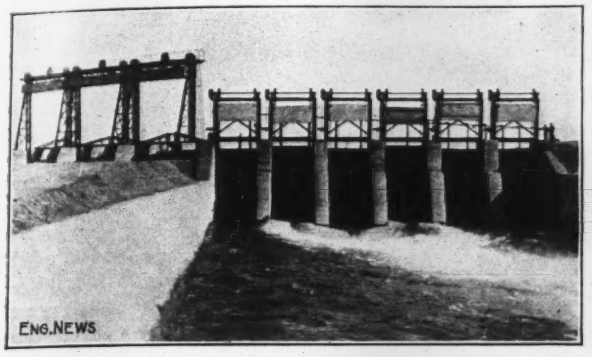


Fig. 3. Sluice and Canal Gates

a manner as to scour out any accumulation of débris in front of the racks. These gates are 8.0 m. (26.25 ft.) long by 5.7 m. (18.70 ft.) wide with a clear lift of 7.0 m. (22.97 ft.); they are of the Stoney type, hand operated.

The floor of the discharge channel in front of the sluices is of creosoted pine 6 in. thick, held in place by 45-cm. (17.7-in.) I-beams partly embedded in the concrete. The planks lie in the direction of the flow of water and are so arranged as to be readily replaced when worn.

The removable racks, 30 in number, are placed in 15 bays as shown in Fig. 2. The rack bars are a special type, spaced 15 cm. (5.9 in.) apart in panels 2.0 m. (6.56 ft.) wide. A traveling differential chain block is used to elevate them for cleaning or repairs.

The intake gates are six in number, also of the Stoney type, 3.4 m. (11.15 ft.) long by 6.0 in. (19.68 ft) high, with a lift of 3.8 m. (12.47 ft.), to be operated by hand. The bottom of the intake forebay has an inclination of 1.5% towards the canal gates. Just in front of these gates is a sand trap and a sluice gate to return to the river the débris that may pass the racks.

Overflow Dam—The dam is of the ogee overflow type, shown in Fig. 2. The foundation is a fairly hard sandstone of varying thickness. The surface is very irregular and heel and toe trenches are excavated into it as shown. Immediately below this sandstone is a stratum of indurated clay varying from 5 to 15 ft. in thickness, and practically free from seams.

No apron was built below the dam as it was decided to wait until the effect of overflowing water on the river bed below the dam could be studied; then if necessary, a protecting apron will be added. This will not be difficult as all ordinary water can be diverted into the canal or passed through the sluice gates and the toe of the dam unwatered.

During construction, the plan was first tried of driving a row of steel sheet piling in line with the upstream face in order to reduce excavation and serve as a cutoff, but the piling did not reach solid material but was bent and doubled so badly by the small gravel that most of it had to be removed by hand before the excavation could be completed. No serious difficulty was encountered in excavating by the ordinary methods in open trench and unwatering by motor-driven centrifugal pumps. The river channels were diverted by timber and stone coffer-dams to alternate sides of the stream bed and finally through the large sluice gates while the closure was made.

The total length of the overflow proper is 393.2 m. (1290 ft.) and the logway opening is 4.5 m. (14.8 ft.) with a low buttress between them of 3.5 m. (11.5 ft.), making a total length between abutments of 401.2 m. (1316 ft.). The dam is capable of passing a maximum of 3750 cu.m. per sec. over the ogee section, 650 through the sluice gates and logway, and 60 into the canal—or 4460 (157,000 sec.-ft.) in all. Fig. 3 shows the completed canal gates and sluice gates.

Power Canal—The first 19.2 km. (11.8 mi.) of the power canal has a grade of 0.00015 and a capacity of 60 cu.m. per sec. (2120 sec.-ft.) and is concrete lined throughout. Fig. 4 shows the type sections for this canal. It will be noticed that these approach the "economic section" i.e., maximum capacity for minimum perimeter and cross-sectional area. This was adopted even at the expense of deep excavation in order to minimize right-of-way and lining costs.

The upper canal for about half its length traverses

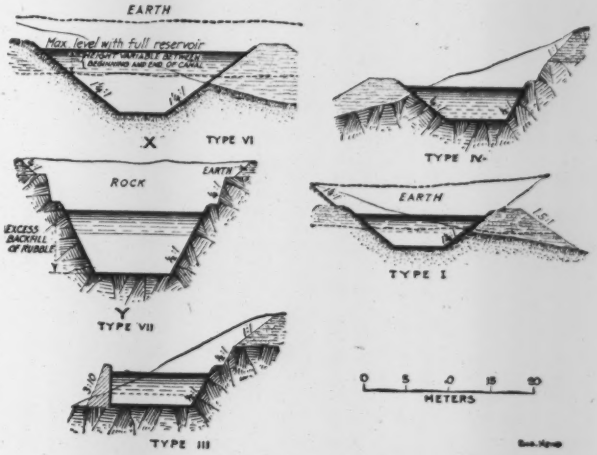


Fig. 4. Typical Canal Sections
(Sections X and Y for Lower Canal)

intensively cultivated lands and a complicated network of irrigation and drainage ditches. In order to pass these ditches without disturbing existing conditions, small inverted siphons were used. In all, there are 43 siphons in the upper canal. These were made of thin steel pipe, with stove-pipe joints, placed in a trench and surrounded by concrete. At the entrance to each is a settling basin, concrete lined, and a grating which prevents floating trash from entering the siphon. In nearly all cases, the velocity is sufficiently high to prevent sedimentation. If, however, they do silt up, they are readily cleaned by passing a cleaning rod made of spring-steel bars smoothly joined in lengths of 14 ft. These act as a needle which is pushed

through the mud or trash and by means of which a rope is drawn through the siphon. To the rope is attached a series of buckets on a chain to remove silt and finally a spherical brush is drawn through, which completes the cleaning.

CANAL LINING—As indicated in the type sections, Fig. 4, the lining is of concrete 10 cm. (3.93 in.) thick. The mixture used was 1:3:6 cement, sand and river gravel (gravel screened to pass in any direction through a 2-in. ring). Attempts were made to place this lining without forms, but the plan was abandoned as it was found to be impossible to place the 4 in. of concrete on a slope of 1¼

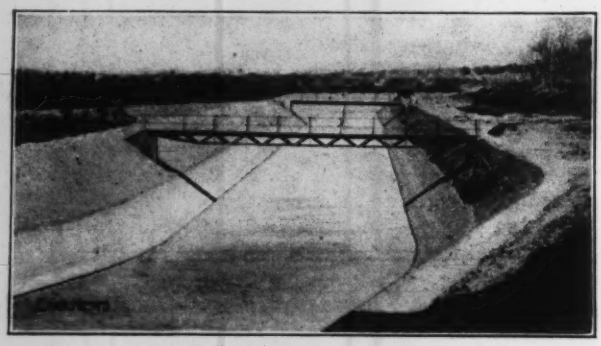

FIG. 5. UPPER CANAL HALF LINED

on 1 without making it so very dry that its impermeability was seriously impaired.

The lining was first carried to 3 m. vertical height only, in order to allow the made banks to settle as long as possible before lining. The remaining 1.7 m. was placed after water was in the canal. Fig. 5 shows a section of canal completed except for the upper strip of lining.

Part of the lining was let by contract and part was done by the company. Figs. 6 and 7 show the forms used by one of the contractors, and a sample of the finished surface. In this system the form boards were placed from the canal side of the 4x6-in. uprights. This was advantageous in that the trimmed slope was not touched and hence the green concrete was kept free from dirt that would otherwise be brushed onto it. This system also had the advantage of being more elastic, as one side could be lined at a time and thus the lining gang could follow the slope trimmers more closely. The most rapid work, however, was done by company forces using the system shown in Fig. 8. At first, continuous mixers were tried but they could not compete either in cost or quality of work with hand mixing, and they were therefore abandoned. In the design of the canal, a coefficient in Kutter's formula of $n = 0.015$ was used for concrete surfaces.

STOP LOG AND WASTE GATES—At three nearly equally distant points on the upper canal, stop-log structures (see profile, Fig. 1) are provided by means of which the water in any section may be held if necessary. These were provisional in nature and served their chief purpose during the testing out of the canal. In each section also there are waste gates with discharge capacity aggregating 12 cu.m. per sec., with the canal full, by means of which any section may be unwatered.

### LOWER CANAL

Some three miles above the power station, the canal line crosses a series of low valleys, seven of which were closed by earth dams to create four regulating reservoirs. The disposition of these is shown in Fig. 1. These four reservoirs are connected by a lined canal having a net length, exclusive of reservoirs, of 4.22 km. (2.62 mi.) and capacity at low reservoir of 120 cu.m. per sec. (4[illegible] cu.-ft.), leading to the penstocks of the power house. The bed of this canal has a grade of 0.00026 while the top of the embankment is level at an elevation 1.0 m. above the maximum operating height of water in the upper reservoir. In this manner the head due to fluctuations in the reservoirs is not lost. In designing this canal the velocity head in the canal was assumed to be lost at the entrance and reproduced anew at the exit of each of the four reservoirs outlined above.

Typical cross-sections of the lower canal are shown in Fig. 4 (marked "X" and "Y"). The same thickness of lining (3.9 in.) is used in this as in the upper canal. Fig. 9 shows lining in progress and gives an idea of the size of the canal and its great depth relative to its bottom width. This type was selected to facilitate control of the elevation of water surface in the reservoirs, from the power house and to make the canal responsive to the fluctuating demands upon it.

This canal is provided with a special stop-log structure at its upper end where it leaves the first reservoir (see Fig. 1) and a set of four waste gates just before entering the forebay. By means of these, the storage water may be held in the reservoir and the lower canals and reservoirs emptied, or the water may all be passed through the canals and reservoirs and returned to the river without passing through the power house. These stop logs are of interest. The channel is divided into three portions by two piers

FIG. 6. SECTION OF FINISHED SURFACE, CANAL LINING

provided with grooves for the stop logs. The logs themselves are made up in leaves 15x4¼ ft. each, of 12-in. timbers, bound with angle irons and fitted at the ends with rollers. Staunching plates project upstream at right angles to the stop logs, and bear against an angle set in the stop-log grooves to prevent the excessive leakage that would otherwise occur.

These stop logs are suspended in the grooves by cables provided with a trip, by means of which they may be

drop[illegible]nstantly into place. Provision was planned to force[illegible] logs down by suspending other logs to channel colu[illegible] that would bear on the stop log that had been dr[illegible]. but it was found that the momentum the log ga[illegible]before striking the water was usually sufficient to c[illegible] it to its seat. Fig. 10 shows the structure (combined bridge and stop) with one opening closed, and three stop logs suspended in each of the other openings, ready to be dropped. As each leaf weighs two tons, a traveling chain block, shown in the figure, was necessary to handle them. This arrangement is temporary and more permanent gates will be installed later.

course, could not be avoided, and on account of the comparatively thin lining it was necessary that the water be raised slowly in order that the effect of this settlement could be observed and any needed repairs made at once. It was observed on some of the higher embankments that the earth settled inwards toward the canal, the first evidence being a crack between the lining and the embankment. As fast as these cracks opened, drill holes were made behind the lining with long drills at intervals of about 18 in., and an almost liquid puddle of clay and water poured into them. In this manner, the support for the lining was maintained and the lining preserved intact. As soon as the bank had taken its settlement no further difficulty was experienced.

FIGS. 7 AND 8. PLACING THE CONCRETE LINING IN THE UPPER CANAL, SEROS PROJECT
(Fig. 7. Contractor's method. Fig. 8. Method of company force.)

### TESTING OF CANAL

The filling of the canals was accomplished with no serious consequences. Settlement of the earth banks, of

Very little lining was broken by settlement, and wherever it did occur, it could nearly always be traced to poor

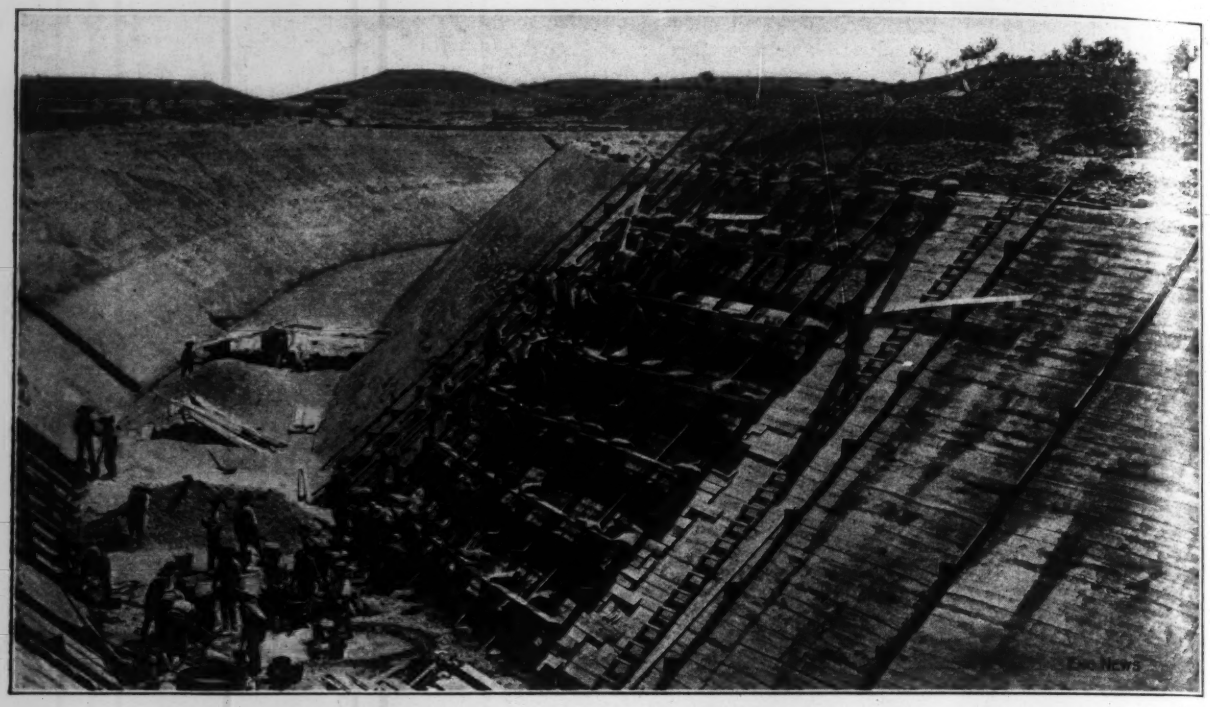

FIG. 9. LINING THE LOWER SEROS CANAL

contact between the upper and lower strips of lining. In spite of eternal vigilence and inspection, the upper strip of lining was begun in a few places before the old surface had been properly squared and cleaned, with the result that when settlement occurred, the upper strip of lining would be taken with the earth, breaking or cracking at the joint. Repairs of this joint was necessary in not over 200 m. of its length, which is very little, considering that this joint was about 45,000 m. long. In all, not over 2000 m. of embankment required treatment after settlement.

Work on the whole project was carried through with speed. Active construction started in January, 1913, and water reached the station forebay Mar. 10, 1914—in 15

FIG. 10. STOP-LOG STRUCTURE, LOWER CANAL

months. The rights-of-way covered 717 hect. (1800 acres); the excavation, exclusive of borrow for earth dams was 2,540,000 cu.yd.; 128,450 cu.m. (167,800 cu.yd.) of concrete and masonry were placed. The various gates and mechanisms came from Ransomes Rapier, Ltd., of London; racks and screens were made by Ammie Geiscke and Konegan of Zurich. Practically all the structural steel was furnished by the Blaw Steel Construction Co., of Pittsburgh, Penn., U. S. A.

### ORGANIZATION

The work was carried out by the Ebro Irrigation & Power Co., Ltd., under the supervision of the Pearson Engineering Corporation, Ltd., of New York City. The following officials were in charge of the work: F. S. Pearson, President; A. W. K. Billings, Vice-President and Managing Director; Fred. W. Abbot, Manager of Construction; J. A. Sargent, Chief Engineer.

The work was executed under the inspection of the Public Works Department of Spain; Sr. Don José Bares, Chief Engineer for the Province of Lerida.

**Checking a Landslide** in a railway cut by breaking up the slope with massive blocks of concrete built in trenches running up the slope was practiced with success on the Ebant & Nesslau Ry. in Switzerland. A sidehill cut had been made through an ancient landslip, the material consisting of clay and loam mixed with boulders and tree trunks, underlaid by a bed of marl. A longitudinal crack, about 200 ft. long, appeared in the slope of the cut, and similar cracks developed in the ground above the edge of the slope, while 33 ft. from this was a main road. A retaining wall was proposed, but it was evident that this would be overturned or carried away before the concrete could set. As an emergency measure, massive concrete blocks were built in the slope, the excavations being carried into the hard material over which the loose mass was sliding, so that the blocks could not move down the slope.

Four blocks, 33 ft. apart, were built, but as the slide continued to squeeze out between them two additional intermediate blocks were built. The slope then stood, but the pressure was so great as to partly raise the blocks, revolving them on their lower ends so that they tended to approach a steeper slope. One block moved outward 32 in. at the top, its foot remaining stationary. The trouble was due to water in the soil, but there was no time to put in any drainage system, and some immediate action was necessary in view of the main road above the cut and the possibility of starting a slide of the whole slope of the mountain above the cut.

# Electric Shifting Locomotives on a Cleveland Ore Dock

At the ore-unloading plant of the Ohio & Western Pennsylvania Dock Co., in Cleveland, Ohio, electric locomotives are used for spotting the cars underneath the unloading plant. When an ore vessel is brought alongside the pier, its hatch covers are removed and the 17-ton grab buckets at the bottom of the traveling legs are dropped into the hold and pick up a load of ore. They then rise out of the hold and are traversed inward until they can drop their load into a 50-ton weighing hopper. As soon as the hopper is filled, a valve is opened and its contents are discharged into an ore car on the track below.

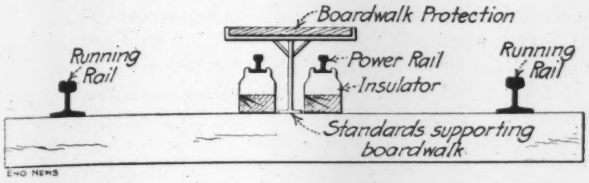


FIG. 1. CROSS-SECTION OF TRACK FOR ELECTRIC SWITCHING LOCOMOTIVE, SHOWING PROTECTED ELECTRIC CONDUCTORS AT THE ORE-UNLOADING PLANT OF THE OHIO & WESTERN PENNSYLVANIA DOCK CO., CLEVELAND, OHIO

It is necessary to accurately spot the cars beneath the ore hopper to prevent the dropping of ore between the cars and this spotting has generally been done by heavy switching locomotives. The difficulty with this system is that the engineer on the switching locomotive at the end of the train cannot see well where to place the car and has to be governed by signals and it is difficult to accurately move a long train of cars by a locomotive at the end. In addition, the smoke and gas from the locomotives are very injurious to the steelwork of the unloading plant. These difficulties have all been overcome on the docks in question by the installation of a narrow-gage track between each pair of railway tracks on which narrow-gage tracks run electric shifting locomotives. These locomotives take their current from a pair of live rails laid in the center of the track and covered by a board walk so that there is no danger of accidental contact with these rails. The accompanying cross-section makes the arrangement clear.

To enable the locomotive to move the cars on the track parallel with that on which the locomotive runs, a heavy braced arm projects from the side of the locomotive and can be rotated on a horizontal axis so that the arm can either be held vertical or can be dropped so that its projecting end comes against the poling iron on the end sill of the car. These steel arms are lowered or raised by compressed air and are under control of the operator in the locomotive cab. Thus the operator can drop this arm between any two cars and work the train of which they are a part forward or backward along the track. It will be seen that by this arrangement of switching the danger which accompanies the common use of poling locomotives on parallel tracks to the cars to be moved is obviated.

The electric locomotives were built by the Baldwin Locomotive Works and are equipped with Westinghouse motors and electrical machinery. They have a total weight of 25 tons carried on four wheels. We are informed that the three electric locomotives in this plant moved last year 60,000 cars on this dock. The general plan of the use of these electric switching locomotives on parallel tracks, with the movable arms for operating the cars, was the idea of Chas. E. Cole, superintendent of the dock company, and we are indebted to him for the information and illustrations here presented.

FIG. 2. THREE VIEWS OF THE ELECTRIC SHIFTING LOCOMOTIVE

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**Triplex Safety Glass**—By-Triplex Glass is built up by layers of glass and sheets of celluloid (xylonite), and is manufactured by the Triplex Safety Glass Co., Albemarle St., W., London, England. On June 27 its resisting properties were thoroughly tested. An army service rifle and ammunition were used at a range of 300 yd., with the following results: (1) 1¾-in. glass. Bullet struck the glass almost in the center, but only penetrated the first thin layer, $\frac{1}{10}$-in. thick. The intermediate and back sheets were cracked; the back, however, remained smooth. (2) 1⅝-in. thick. Bullet struck bottom left-hand corner, penetrating one layer of glass and one of celluloid without going farther. (3) A 1¼-in. piece was badly damaged, but as not penetrated.

An important quality of this glass is that although it may be badly cracked it still remains airtight and waterproof, on account of the celluloid between the layers of glass.

# Water Filtration and Softening Tests at Cleveland, Ohio

By Hippolyte Gruener*

*SYNOPSIS—A working-scale coagulating basin and mechanical filter were constructed and tested at Cleveland to obtain information for guidance in designing a mechanical-filtration plant. The tests have included (1) alum; (2) ferrous sulphate and lime, and (3) lime alone as coagulants, as well as lime for softening. Boiler and laundry tests have been made as well as studies of after deposits and growths on the filter sand. Slow sand filtration has also received attention.*

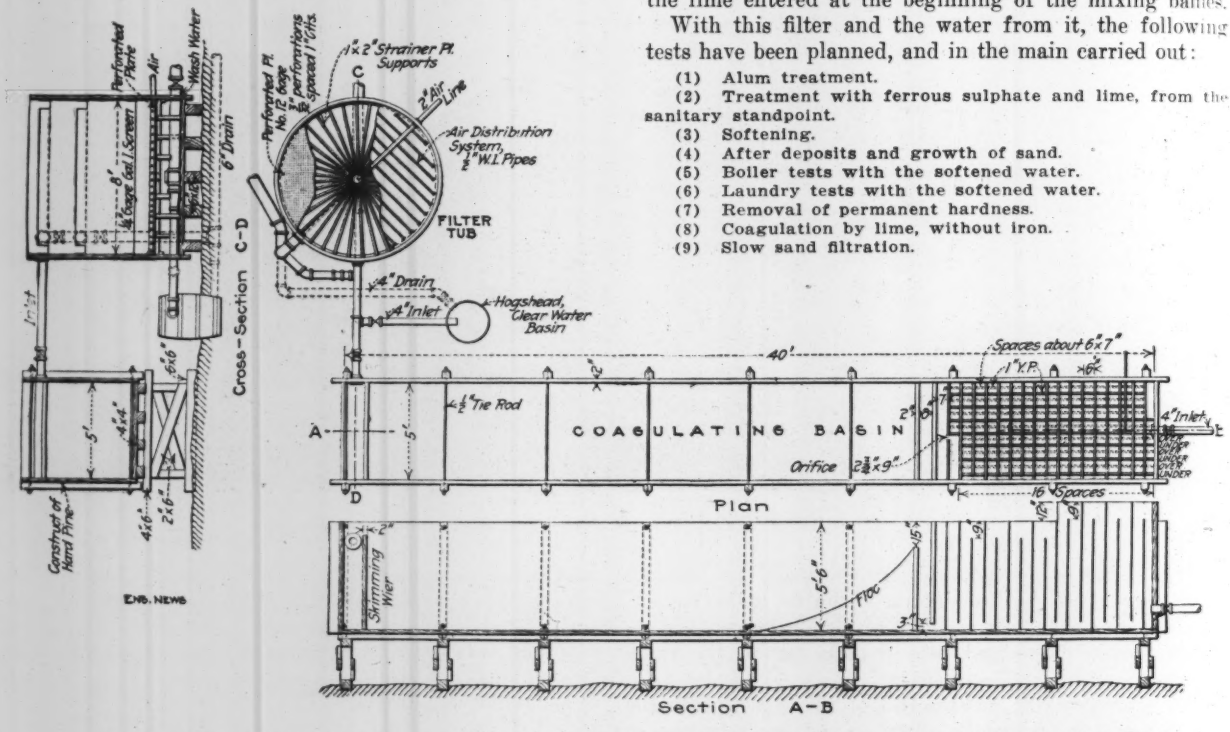
The Ohio spring floods of March-April, 1913, had such a bad effect upon the Cleveland water-supply as to lead the city authorities to adopt a general plan for water filtration. Accordingly, in May, 1913, Mayor Newton D. Baker appointed a Filtration Commission of five members, whose names are given at the close of this article, to study the situation and to make recommendations. It was decided at the outset that mechanical filters would be used but it seemed desirable to make a careful study of local conditions and to establish and operate a test plant before deciding on all the features of the new purification works.

The water-testing or experiment plant, which was put in operation in July, 1913, consists of a coagulating tank and mechanical or rapid sand filter, shown by the accompanying line drawings. The intention was to operate the filter at the rate of 100,000 gal. a day but on account of the small size of the coagulating tank the plant has been operated at a 50,000-gal. rate. When the filter is worked at this rate, the detention period in the coagulating tank is 2½ hours. The filter was equipped for using air preliminary to reversing the flow of water in washing, but the air wash was seldom used, as the pressure of the wash water, run from an elevated tank, was sufficient for ordinary purposes.

When the difficulties of manipulation had been overcome, this filter gave very good results, especially after the introduction of a very efficient mixing device. This consists of a series of baffles, through which the water moves for 30 minutes through a total distance of 1050 ft. Ordinarily, the iron was introduced at the pumps, while the lime entered at the beginning of the mixing baffles.

With this filter and the water from it, the following tests have been planned, and in the main carried out:

(1) Alum treatment.
(2) Treatment with ferrous sulphate and lime, from the sanitary standpoint.
(3) Softening.
(4) After deposits and growth of sand.
(5) Boiler tests with the softened water.
(6) Laundry tests with the softened water.
(7) Removal of permanent hardness.
(8) Coagulation by lime, without iron.
(9) Slow sand filtration.




Plan of Coagulating Basin and Mechanical Filter, Water-Testing Station, Cleveland, Ohio

(1) Alum Treatment—The turbidity and bacterial content of Lake Erie water vary, but the more important dissolved solids fluctuate very little. The alkalinity is about 90 to 95 p.p.m., with practically no excess of free carbon dioxide or of normal carbonate. There are in addition 16 p.p.m. of permanent hardness, mainly sulphate. With this alkalinity the water responds to alum treatment, and the first trials were with this coagulant. The turbidity of the raw water during the period of trial was only 7. Beyond the removal of this turbidity and the study of the difficulties of manipu-

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later, this test had little value, as it was deemed advisable to change to lime and iron before good results were obtained.

(2) Lime and Iron Precipitation—This absorbed the chief interest on account of its relation to the possible softening of the water. After the difficulties of manipulation had been overcome and the final method of procedure adopted, the filter produced water which showed a turbidity of zero, and only once fermentation with lactose-bile in 10 c.c. This was during a period of six months, during which period 118 tests were made. The raw water showed considerable gas for 70% of the time. The special features which mark this long period of practically perfect results, were, aside from the general improvement in the handling of the plant, the large dosage of lime, and the diminution of the rate of filtration from 130,000,000 gal. per acre daily to 70,000,000, and finally to about 50,000,000. This lower rate was adopted in order to attain the desired time, 2.5 hr., in the coagulating basin. And this rate is the one which corresponds, with few exceptions, to the results reported in this article. For part of the time, during which only 2 to 3 grains of lime per gal. were used, with 0.5 grain of iron, the effluent was good. But the question of softening was kept so definitely in view that the dosage of lime was early adjusted to this end, and the sanitary efficiency worked out on this basis. The dosage finally settled on was: lime, 4.3 grains per gal.; iron, 0.5 grain per gal. The mean rate of filtration at this dosage was 51,500,000 gal. per day.

The data for the period of successful operation are as follows: Time, Nov. 8, 1913, to May 1, 1914, or 6 mo.; Number of tests, 118.

| | Raw water | Filtered water |
|---|---|---|
| Mean turbidity | 47 | 0 |
| Mean bacterial count (agar) | 46 | 3 |
| Fermentation, per cent. of days | 70 | 1 |

In the early stages of the operations some trouble was experienced by high counts, due to bacterial growth in the filter bed. This was remedied by occasional introduction of small amounts of bleaching powder into the wash water.

The main purpose of the filter was established by this series of tests, namely, the certain production, for a long period of time and during varying conditions of season and state of the raw water, of an effluent free from turbidity and also from coli (as shown by presumptive tests).

(3) Softening—As soon as it was clear that satisfactory sanitary results were obtainable by lime and iron treatment, the emphasis of the tests was laid upon the softening. The reason which prompted these experiments was that it seemed desirable to obtain for the city the best water in every respect. Although the raw water is not extremely hard, it is hard enough to warrant its softening if this can be accomplished easily. The cost of softening will be more than repaid in the saving of soap, and the added comfort in home and laundry will be clear gain. There are industries in which the use of soft water would be advantageous, and in some boiler practice, at least, the improvement may be noteworthy.

An analysis of the water is given below. The amount of lime required may conveniently be measured by the total carbon dioxide in the form of acid carbonate, plus the magnesium present as carbonate. This will remove the excess carbon dioxide which holds the calcium and magnesium in solution as acid salts, and changes the magnesium carbonate into the less soluble hydroxide. More lime converts the sulphate and chloride of magnesium into hydroxide also. These changes are shown by the equations:

1. $CaH_2(CO_3)_2 + Ca(OH)_2 = 2CaCO_3 + 2H_2O.$
   $MgH_2(CO_3)_2 + Ca(OH)_2 = MgCO_3 + CaCO_3 + 2H_2O.$
2. $MgCO_3 + Ca(HO)_2 = Mg(OH)_2 + CaCO_3.$
   $MgSO_3 + Ca(OH)_2 = Mg(OH)_2 + CaSO_3.$
   $MgCl_2 + Ca(OH)_2 = Mg(OH)_2 + CaCl_2.$

The calcium carbonate and magnesium hydroxide are usually assumed to be insoluble, but where results are considered exactly, their solubility is not to be neglected, and, in the water treated as above, the hardness left in the water on their account is about 35 p.p.m. In addition, the soluble sulphates and chlorides are not converted to an insoluble form, and this hardness is unchanged. The amount of lime required for softening is: for half-bound $CO_2$, measured as $CaCO_3$, 95 p.p.m.; for $MgCO_3$, in addition, 13 p.p.m.; total, 108 p.p.m. Expressed as CaO this is 61 p.p.m. or 3.5 grains per gal.

Experience showed that the best results were obtained when enough lime was added to precipitate all the magnesium salts, namely, 21 p.p.m. as $CaCO_3$ or a total of 4.2 grains per gal. (73 p.p.m.) The amount applied varied from 4 to 5 grains, on account of imperfections in the feeding device, the average for the time under discussion being 4.35 grains. Due to this irregularity of feeding, the daily records for dosage and softening effect do not correspond, and the averages of the whole period need to be taken for a proper conclusion. These averages were: lime applied, 4.35 grain per gal.; iron, 0.50 grain. The average alkalinity for this period was 38; total hardness, 57. The average alkalinity to phenolphthalein for the period was 15. There were unusually high phenolphthalein alkalinities, for which the explanation was not evident; but in general, as long as the phenolphthalein alkalinity is not more than half the methyl orange alkalinity, it is true that there is no excess of lime present. The raw water had an average alkalinity of 88.5 and a hardness of 104.

Analyses of the raw and filtered waters, expressed as $CaCO_3$ p.p.m., with samples taken when the hardness was low, were as follows:

| | Raw | Filtered |
|---|---|---|
| Calcium | 82 | 29 |
| Magnesium | 34 | 24 |
| Total hardness | 116 | 53 |
| Soap hardness | 110 | 49 |
| Alkalinity, methyl orange | 95 | 35 |
| Sulphate | 14 | 18 |
| Chloride, over alkali | 2 | 2 |
| Hardness by this test | 111 | 55 |
| Total solids | 139 | 74 |

There have been a few results even more favorable than this typical one, but they could not be consistently obtained. The long series of experiments, both bottle and by means of the filter, indicated that we had here the best conditions. Less lime means incomplete precipitation; more lime means free calcium hydroxide and more hardness.

It is evident from the many series of bottle tests and from the long-continued filter test, that the Cleveland water is easily softened to the extent of about 50%. The residual hardness consists of the original permanent hardness, 16 parts; of hardness added by the ferrous sulphate, 3 parts; and of the hardness due to the solubility of the so called insoluble calcium carbonate and mag-

nesium hydroxide. This last item seems to be somewhat variable, at least under the conditions offered by the test filter, and a study of the data fails to reveal the causes of the variations. The evident means of control are proper dosage, thorough mixing and agitation, and finally filtration through sand. Aside from these variations, within narrow limits, no difficulties of permanent importance developed. The water was absolutely attractive in appearance and flavor, and sought after for drinking purposes by such as had the opportunity.

The time covered fall, winter and spring, with a range of temperature of the water from 64° to 33°. The effect of this change of temperature was not apparent.

The amount of wash water used at the beginning was high, 5 to 6%. With increased skill, use of baffles, lowering the rate of operation, and with bleaching powder in the wash water, it was reduced to about 1.7%. At the rate of 130 m.g.d., the time between washings was only 4 to 6 hours. When the rate dropped, the time increased correspondingly. Later, however, when the rate was 50 m.g.d., the time was increased in much greater proportion, namely, to about 40 hours.

(4) After Deposits and Growth of Sand—So far, no objection or obstacle has developed which threatens to interfere seriously with the plans for softening as just outlined. The effluent will be saturated or even supersaturated with carbonates of calcium and magnesium and magnesium hydroxide. Which of these are present, and whether the substances are present as supersaturated solutions or in colloidal condition, or whether the reaction is retarded, are questions difficult to answer. The quickest and most practical solution of the problem is an empirical one. That is, if there are no serious deposits, the matter may be passed over. If there are serious deposits, they must be prevented by the addition of carbon dioxide or by regulation of the dosage, with consequent lessening of the softening effect.

With abundant access of air, the absorption of carbon dioxide might be sufficient to eliminate the danger. But it is unlikely that absorption of that gas will be of any importance in the short passage from the filter to the mains. Artificial addition of carbon dioxide may be considered within the bounds of possibility, but for the present this may be left out of account. The thorough mixing by the baffles, followed by four hours settling and by filtration through sand, may solve the problem. What experience we may refer to in St. Louis, New Orleans and Columbus has been reassuring. At the test filter no deposits have come to the attention of the operator. Pebbles left in the water at the outflow showed traces of calcium carbonate after several months. Three litres of water standing in large flasks for six months deposited a total of 0.0009 gram of calcium oxide and 0.0003 gram of magnesium oxide. A piece of porcelain having an area of 80 sq.cm., including both sides, was left in the water two months, after which 0.0012 gram of calcium oxide were found to be deposited on it. On the other hand, as already stated, there has been no evidence of deposit in any way ordinarily noticeable.

The sand is bound to grow [by accretions] and its renewal must be considered as a part of the regular plan. A specimen of the sand from the filter, after being in use six months, was found to lose 3.3% of its weight when treated with dilute hydrochloric acid; another specimen, after 11 months, lost 12.5%. The composition of this incrustation was determined and found to be as follows: $Fe_2O_3$, 3.6%; $CaCO_3$, 90.7%; $MgCO_3$, 3.6%. Sand from the lower layers showed less incrustation, namely, about 7%, with the same chemical composition as that shown above.

In the upper layers of the filter considerable amounts of the sludge collected in soft masses, which penetrated to a depth of 6 to 8 in. and were not removed by the routine washing. The sand could be cleaned completely when removed from the filter and washed with some agitation. The composition of this sludge is: matter insoluble in HCl, 4%; $Fe_2O_3$, 3.0; $CaCO_3$, 87.15; $MgCO_3$, 4.03%. If this is reduced to the composition of the soluble matter only, we have: $Fe_2O_3$, 3.1%; $CaCO_3$, 90.8%; $MgCO_3$, 4.2%. That is, nearly the same composition as the incrustation on the sand.

Although the sand growth introduces complications, there may be some compensations in connection with it. The growth represents a diminution in the hardness of the water, and, what is more important, probably removes that portion of the dissolved substances which might afterwards settle out in the pipes. With respect to this precipitating effect of the sand, the record of a series of six bottle experiments and nine test-filter experiments will be of interest. In these the water was softened with lime, iron also being used, and soda added to remove the permanent hardness. Part of this water was filtered through paper, and part through sand, with the following results:

| | Methyl orange alkalinity | Hardness, soap |
|---|---|---|
| Bottle experiments: | | |
| Sand | 37 | 36 |
| Paper | 43 | 43 |
| Test filter experiments: | | |
| Sand | 38 | 53 |
| Paper | 44 | 58 |

(5) Boiler Tests—Two tests of the filtered and softened water have been made in the boilers of the pumping station. The softening of the whole city supply for the sake of boiler practice has not been suggested. If, however, a gain in this respect could be shown, it would give increased impetus to the interest in softening for domestic reasons. The records of two tests are as follows:

(1) 43 days. Water used, about 9,000,000 lb.
Raw water, using soda as boiler compound: Flue scale, 121 lb. Total scale and mud, 190 lb.
Filtered water: Flue scale, 42 lb. Total scale and mud, 64 lb.

(2) 30 days. Water used, about 6,000,000 lb.
Raw water: As first test. Flue scale, 14 lb. Total scale and mud, 83 lb.
Filtered water: Flue scale, 13.5 lb. Total scale and mud, 30 lb.

Even if improved efficiency in the use of the boilers cannot be demonstrated, the difference in amount of scale is very large. The scale from the softened water, as is to be expected, contains larger proportions of calcium sulphate and of magnesium, and is noticeably firmer but not enough so to make any difference in the use of the cleaning machines.

(6) Laundry Tests with the Softened Water—Two tests were made. The first at a city institution where only towels were laundered. The saving of soap, measured somewhat crudely, was about 25%, or even more, and the work seemed to the operator to be better done. The second test was carried out at a large commercial laundry, under the personal supervision of the superintendent. His estimate of the saving of soap and supplies was 25%. No marked difference in the quality of the work was apparent.

The question of the amount of soap saved by the

use of softened water is a difficult one to answer, as estimate forms such an important factor in every calculation. For the present purpose, it will be enough if it can be shown that the cost of softening is covered by the saving of soap. Until more exact knowledge is obtained, Whipple's estimate that at least 1 gal. of water is softened for every 100 gal. of water used, may be considered sufficiently conservative. Further using his formula ("Value of Pure Water," p. 27), the saving of soap at 5c. per lb. amounts to $360 for 60,000,000 gal. of water softened from 115 to 55. On the more conservative basis of the chemical equivalent between the calcium and the soap, the saving would be $125, which is about equivalent to the total cost for coagulants, and if at all correct, must be safely above the cost incurred for the softening only.

(7) Removal of Permanent Hardness—This amounts to 16 p.p.m. in the raw water, and is increased to about 19 parts by the added sulphate. Bottle experiments indicate that soda will remove this completely, when added in theoretical amounts, well agitated with the lime and subsequently filtered through sand. The mean result of six experiments thus conducted, with somewhat varying minor conditions, was: alkalinity to methyl orange, 37; soap hardness, 36. Consistent results better than this average could probably be obtained. This would give a very satisfactory softening. The first experiments made with the test filter have not been equally satisfactory, due perhaps to inadequate agitation. But even if the later tests confirm this result, it is hardly likely that this further softening will be adopted for the permanent filter, as the cost will be too great. The 1.2 grain soda required, amounting to 5 tons a day, would cost $100 for 60,000,000 gal. This would be for a reduction of only 19 parts, and is possibly in excess of the advantages obtained, especially when the handling of another chemical and all it involves is considered. Yet according to Whipple's calculation, even this would be paid for by the soap saved. A reduction of the hardness to 30% sounds attractive.

Coagulation by Lime, without Iron—The test was run for five days, with no modifications besides the omission of the iron. At the end of this time, the filter was required for other work. The inefficiency of the coagulation from the bacteriological standpoint was soon demonstrated. The second day there was a trace of gas; the third, 30%; the fourth, 35%; the fifth, 50%, each in 10 c.c. The turbidity during these same days was 0.0, trace, 2.5. The unfavorable impression was confirmed by the results from bottle experiments dealing with the sedimentation in the tank.

(9) Slow Sand Filtration—A slow sand filter was operated for several months until the freezing weather interfered. The filtration was efficient from the standpoint of turbidity. The bacterial results were not uniform. A number of periods of satisfactory results were obtained, from which it might be inferred that after all the manipulative difficulties had been overcome, the filter would operate satisfactorily. As, however, all considerations had led to the adoption of the rapid type, no further tests seemed necessary.

The writer must disclaim credit for a very considerable portion of the investigations recorded above. The test filter was operated under the general direction of the Filtration Commission of Cleveland, with the cooperation of the Water Department. H. B. Hommon, G. E. Flower, and G. D. Makepeace have been in direct charge of the test filter. The members of the Filtration Commission are as follows: President, A. W. Smith, Professor of Chemistry, Case School of Applied Science; Secretary and Consulting Engineer, R. Winthrop Pratt; Dr. Wm. T. Miller, member State Board of Health; Hippolyte Gruener, Professor of Chemistry, Western Reserve University; and Dr. R. G. Perkins, City Bacteriologist and Professor of Hygiene and Preventive Medicine, Western Reserve Medical School.

## Ohio Experience in the Use of Road Oils*

Poor results in the use of oil treatments frequently come from the fact that the surface had not been previously cleaned in a proper manner. If possible, the surface should be swept with horse sweepers, and afterward with hand brooms, so as to remove the dust from between the stones to a depth of from ¼ to ¾ in. The heavier the grade of oil used, the more important it is to have a clean surface on which to apply it. The surface should be dry and the warmer the air temperature the better.

There has been considerable discussion during the past year concerning sprinkling of the stone with water before applying the bitumens, it being claimed by some that better results are secured. While during a dry, dusty time, better results may be obtained by first lightly sprinkling the stone with water before applying the bitumen, this information is likely to be misleading; for it is believed that it is not the presence of water that might cause the better results, but the effect the water has in cleaning the dust which gives a better adhesion of the oil.

Hence, we would conclude that if sprinkling with water before applying the oil is done, it should be only on hot, dry days, and then sufficient time given after the sprinkling for the water to practically all evaporate before the oil is applied. Therefore we are still warranted in saying that bitumens should be applied only to dry, warm surfaces. During June, July and August is the best time of the year to apply such materials to the road.

The amount of oil that should be applied to the road at any one time will depend upon the condition of the road surface, the quality of the oil used, and the nature of the traffic. In general, it may be said that a couple of light applications during the year will give better results than a single heavy application of the same amount of oil. For the lighter oils, on a comparatively smooth surface, an application of not to exceed ⅛ gal. per sq.yd. may be all that should be applied at one time, while on a rough, pitted surface (with the binder swept from the top surface of the road to a depth of from ¼ to ¾ in.) as much as ¾ gal. per sq.yd. of the heavier oils might give more satisfactory results.

The aim should be to put on just sufficient oil (and screenings) to form a thin mat over the surface of the road. This mat should not be of any appreciable depth over the surface of the larger stones, but sufficient to well seal up the voids between them. This will hold the binder in the stones and make the road surface water-tight.

A medium heavy cold oil will cost from 4½ to 6c. per gal., delivered in tank cars. The cost of applying the cold oil varies from ½ to 1c. per gal., while the cost of applying the hot oil will vary from 1½ to 3c. per gal.

*From Bulletin No. 27, Ohio State Highway Department, June, 1914.

# The Design and Construction of the Bassano Dam--Part II

By H. B. Muckleston*

As stated in my previous article [Eng. News, Aug. 27, 1914, p. 425] the Bassano Dam is located on the Bow River, and is a part of the immense irrigation system of the Canadian Pacific Railway which extends from near Calgary, Alberta, many miles to the eastward. The dam is a composite structure, consisting of a long earth embankment and an Ambursen reinforced-concrete spillway section, provided with Stoney gates, flanked on one side by reinforced-concrete head-gates, also provided with Stoney gates.

## Layout of Plant

Construction was commenced in October, 1910, with the erection of the plant and building of Coffer-dam No. 1. Fig. 1 shows the general layout of the construction plant. Three cableways with spans of 975 ft. were erected, requiring tail towers 95 to 85 ft. in height on the west shore, and head towers from 47 to 55 ft. high on the east shore. The two upstream cableways, which were used for handling forms and concrete, each had a carrying capacity of three tons, whereas the downstream cableway, used exclusively for gravel, had a capacity of five tons.

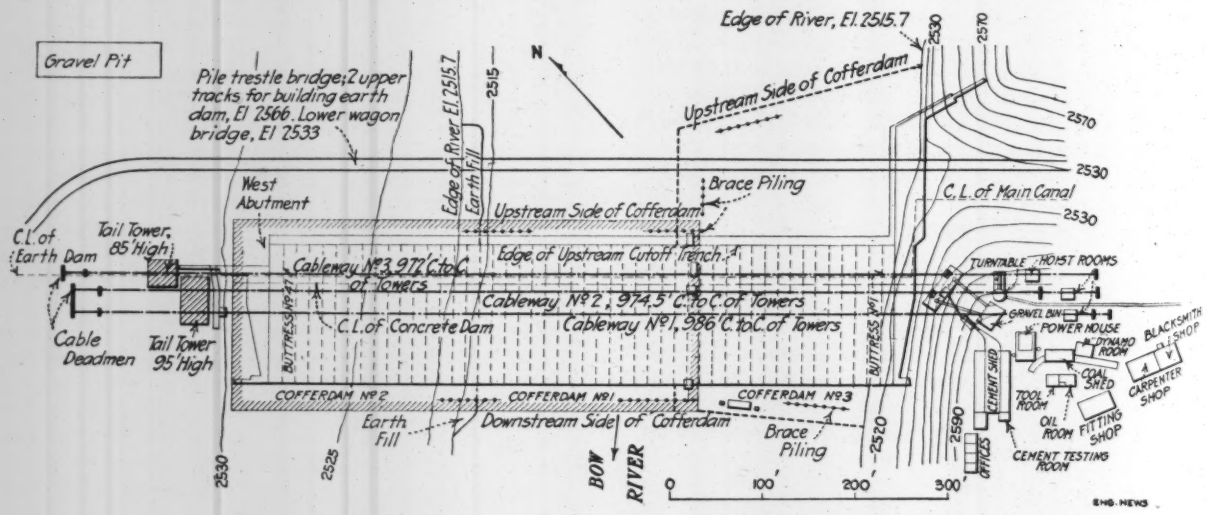


Fig. 1. General Layout of Construction Plant for Bassano Dam

Gravel—A gravel pit, located about 500 ft. west of the west abutment and on the upstream side of the earth dam, was opened up, requiring about 16 ft. of stripping. The gravel was found to be naturally well graded, very clean, and containing about 10% excess of sand. The stripipng and excavation was done with a 1-yd. orange-peel bucket, mounted on a traveling-derrick car. The stripping was as a rule done during the night, and in the daytime the gravel was excavated and conveyed in dump wagons to a trap located under the gravel cable. From here, it was shot into a 2-yd. bucket, which was picked up by the cableway and carried to the 200-yd. gravel bin on the east shore. Two 18-in. steel pipes with sliding controlling gates conveyed the gravel from the bin to two measuring hoppers located above the two 1-yd. Smi[illegible] mixers (Fig. 2).

Cement and Concrete Handling—The [illegible]ent, which was stored in a cement shed with a ca[illegible] of 800 bbl., was by means of an overhead conve[illegible]ar-ried to a hopper whence it was shot down through [illegible]-in. pipe into a bin placed between the two mixers. [illegible]bin was equipped with two spouts in which were fixe[illegible]eas-uring slides for the different mixtures, and the [illegible]ent was in this way distributed to the measuring [illegible]ers which contained the gravel. The whole of the d[illegible] mix-ture was then by a tripping device dumped into th[illegible] mix-ers. The two upstream cableways, located directl[illegible]bove the mixers, picked up the concrete buckets, whic[illegible] were of the controllable bottom-dump type, and carried [illegible]them to wherever concreting was under way. Here the co[illegible]rete was transferred to a controllable bottom-dump car, [illegible]which traveled on sectional track resting on the forms. The maximum output of this concreting plant was 350 [illegible]cu.yd. per 10-hr. day.

Owing to the considerable size of the construction plant, well appointed repair shops were installed so that delays might be avoided and repairs and general maintenance carried out in an efficient manner.

The size of crew engaged varied considerably from time to time, the maximum number being about 250. The unskilled labor was principally Italian, the skilled labor being of all nationalities. Suitable bunk houses and dining rooms for each class, electrically lighted and steam heated, were built, and a water-works and sewerage system installed. As the river water was contaminated to some extent, especially during low water, all water for camp and cooking was chlorinated.

All plant and construction materials were shipped to Bassano, a railway station about four miles from the dam, from which point the hauling was done partly by teams and partly by traction engines.

As the high-water period generally commences about the middle of May and lasts well into August, it was necessary to have each section so far advanced in construction before that time that work could be continued even if the coffer-dams were flooded. The general con-

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FIG. 2. GRAVEL BIN AT BASSANO DAM, WITH GATE-CONTROLLED PIPES LEADING TO MEASURING HOPPERS OVER CONCRETE MIXERS

struction program was therefore arranged accordingly.

COFFER-DAMS—The first coffer-dam constructed took in the central third of the structure, and the river was passed through the easterly third. Upon completion of the central third to a level above high water, the coffer-dam was removed and the river passed through between the buttresses. The westerly third was then started, upon completion of which the easterly third was commenced, with the river passing through the central and westerly section, the design of the type of structure lending itself admirably to such a procedure (see Fig. 3). The coffer-dams consisted of two rows of piles 12 ft. apart, the piles in each row being 8 ft. c. to c. The outside row carried walings supporting 3-in. tongued-and-grooved sheet piling, which was driven with a steam hammer, the back row acting as brace piling. As the river is fairly shallow at the dam site, the greatest depth at low water being only 8 ft., no particular trouble was experienced in the construction of the coffer-dams.

FORMS—All forms used were sectional. Fig. 4 shows their general arrangement, which has been described in various articles on similar dams in the ENGINEERING NEWS. One departure from general practice, however, was that of removing one entire group of forms together by means of the cableways and reërecting them without taking them apart. This process is shown by Fig. 5, where a whole set of forms for the side of one of the buttresses is being removed for reërection elsewhere.

EXCAVATION—Most of the excavating was done by teams, wagons and slip scrapers. As the work was continued all the year round, special arrangements had to be made for thawing out the ground. At the end of the day tarpaulins 100x150 ft. were supported by means of horses over the excavation and numerous salamanders placed underneath and kept stoked overnight. In the morning the canvas and the salamanders were removed and work continued. In this way it was possible to gradually thaw the frost out of the ground, although in places it was frozen 6 ft. deep.

PROGRESS—Concrete was first poured in Floor Bay No. 17 on Mar. 22, 1911, and continued without interruption practically until November, 1912, when the bulk of the concrete had been placed.

During the time no stops were made except when the

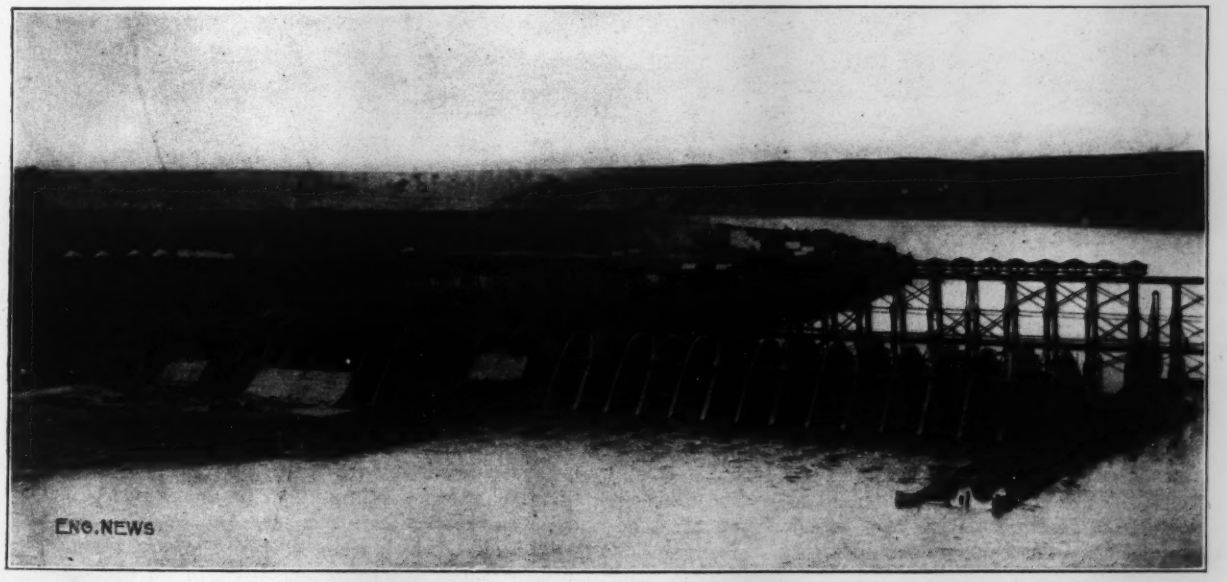



FIG. 3. BASSANO DAM UNDER CONSTRUCTION, AUG. 1, 1911

(The central third is passing water between the buttresses; the left-hand third is under construction; the right-hand third not yet begun.)

FIG. 4. GENERAL ARRANGEMENT OF SECTIONAL FORMS; JULY 15, 1911

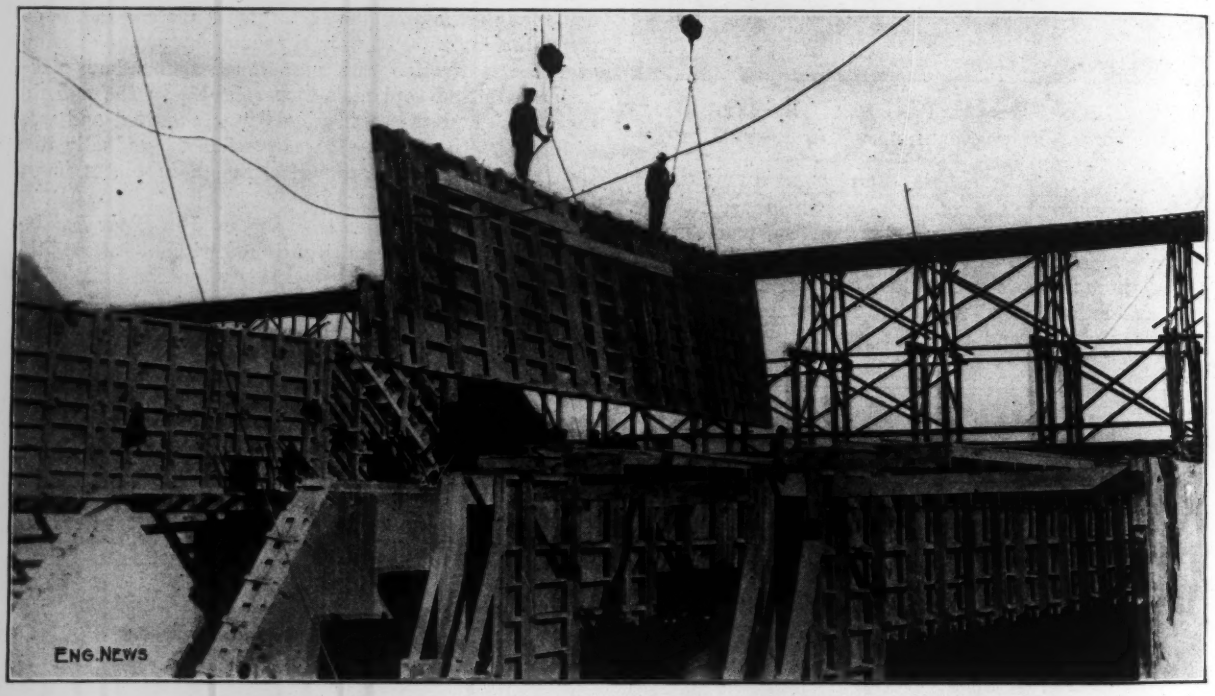



FIG. 5. MOVING A SET OF BUTTRESS FORMS BY CABLEWAY, OCT. 15, 1911

thermometer fell below —15° F., when concreting was suspended until the weather got milder. Special provisions were made when the plant was erected for heating the water and gravel, and as all the forms were double boarded no difficulty was experienced in keeping the concrete from freezing. In fact, it was noted on many occasions that the concrete would still be steaming hot when the forms were removed about four days after the concrete was placed. Construction was resumed in April, 1913, and completed in May, 1914, during which period the canal walls and the housings over the headgates and power house were completed. In November, 1913, the temporary closure of the dam was made with 12x12-in. stop logs, as shown by one of the details in Fig. 4, followed immediately with the permanent concrete closures, the driving of the piling under the lower part of the ogee curve and the concreting of same.

The piles, which were 12x12-in. square timbers shod with cast-iron points, were driven to an average depth of 25 ft., with two 1½-ton steam hammers, in inclined leads. This work was done inside a coffer-dam built on the concrete carpet and the river taken care of by means

of the two 6-ft. under sluices in the middle of the structure (Fig. 6). The gravel fill inside the dam was pulled by trains running on the bridge deck and loaded by a steam shovel located at a gravel pit at the west end of the earth dam. The gravel was dumped into hoppers and conveyed to the interior of the dam by means of spouts passing through holes cut in the crest.

Sluices—The Stoney sluices and all their machinery for both the dam and the headworks were manufactured by Ransomes & Rapier, Ltd., of London, England. They are of the usual type, working on free rollers and stanched by a rubber-covered round rod hung in the angle between the pier and the skin of the gate. Each sluice is provided with means for hoisting by hand. Power operation for the crest sluices is provided for by four movable trolleys on the bridge, arranged to engage any one of the operating shafts. In the case of the canal head sluices a separate motor is provided for each gate. In order to prevent any possible damage from over-winding, each gate is equipped with a limit switch which breaks all electrical connections when the gates approach within 3 in. of the full travel at either end.

The design for the gates and operating mechanism was worked up by the manufacturers under specifications drawn up by the engineers of the Railway Company. The gate, guides and machinery were shipped in the knock-down, and erected by the Railway Company under the supervision of an expert erector sent out from England. So well had the work of manufacture been done that the various parts went together with little or no subsequent alterations or fitting

Auxiliary Gate—As an emergency closure in case of accident to the main crest sluices, a special auxiliary gate is provided. This gate is similar to the permanent gates except that the position in the guides is reversed so that the skin is on the downstream face of the girders instead of the upstream face, and that an endless chain of live rollers working on the gate is provided instead of the rigid roller trains provided for the main sluices.

The auxiliary gate is handled by a gantry crane running on rails on the bridge girders. As the gate will be used but seldom, no provision is made for counterweights or power operation.

Power Plant—As stated above, the time factor in flood rises is so small that special provision was necessary to insure very rapid operation of the crest and canal sluices. To provide electric power for this work, a small power plant was built in a chamber provided for the purpose in the east abutment. The plant consists of a 180-hp. reaction turbine, with Woodward governor, connected by belt to a 100-kv.-a., three-phase, 60-cycle, 2400-volt generator. The plant is equipped with step-down transformers furnishing current at 110-220 volts for the operation of the motors and for a complete lighting system in the dam and about the headworks.

Fig. 6. Making the Permanent Concrete Closure of the Bassano Dam; Nov. 30, 1913
(The river flow is being passed through two 6-ft. under sluices.)

A view of the finished dam, looking along the top from the head-gates end, is shown by Fig. 7.

Earth Embankment—The earth embankment (Fig. 8) was built of selected material from the canal cut. The specifications provided for the most approved methods of construction by spreading and rolling the materials in thin layers and for sprinkling if found necessary. The rear half of the dam is underdrained in order to steepen the plane of saturation, and to intercept any possible flow along the surface between the dam proper and its foundations. Before commencing construction, the foundation surface was carefully stripped of surface soil and thoroughly plowed to give a good bond.

The contractor for the earth portion commenced work by building a double-track narrow-gage trestle across the river. On the right bank, this trestle was continued as two single-track trestles about 100 ft. apart. The material was loaded into dump cars and hauled by locomotive to the dam, where it was dumped from the tres-

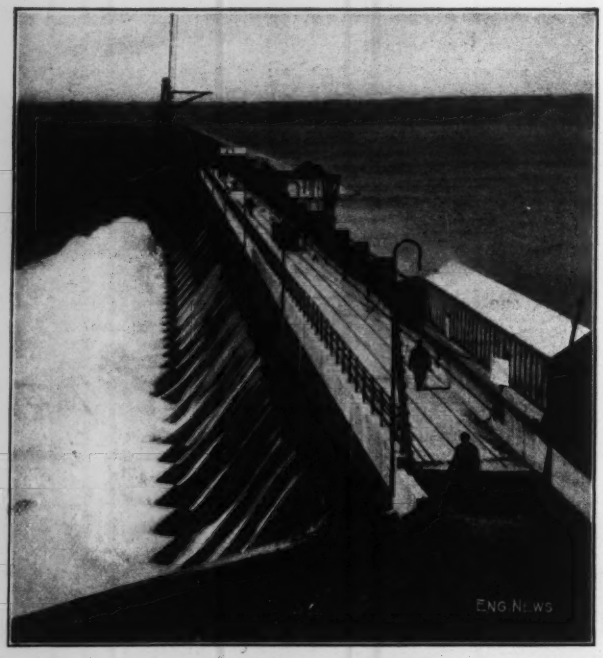



FIG. 7. LOOKING WEST ALONG THE TOP OF THE BASSANO DAM

tles and spread by four-horse Fresno scrapers. The continual trampling by four horses abreast, and the thin spreading which this method resulted in, gave such a thoroughly dense bank that the clause of the specifications relating to rolling was not exacted.

At the connections with the spillway the earth was very carefully spread and compacted. A good proportion

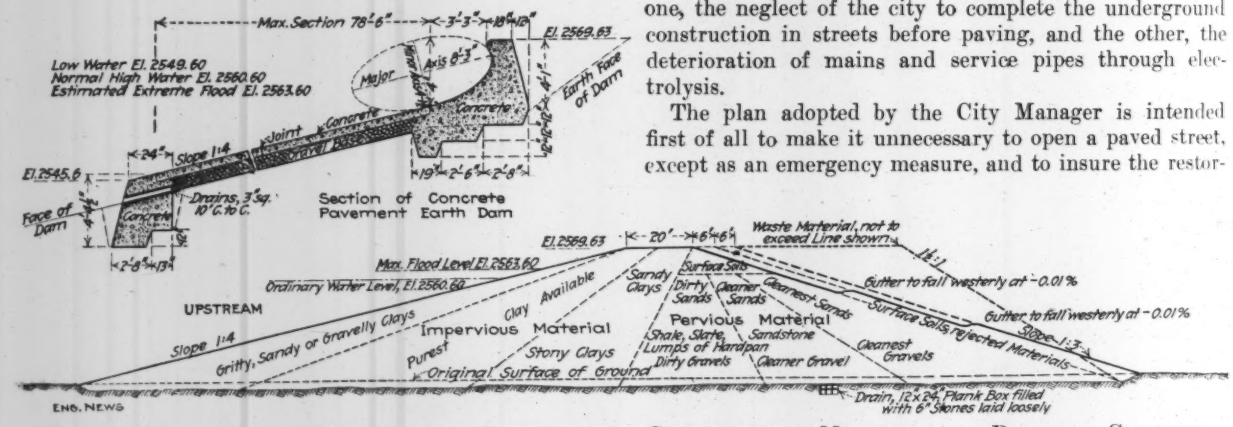



FIG. 8. EARTH EMBANKMENT, BASSANO DAM, SHOWING DISPOSITION OF MATERIALS AND DETAIL OF CONCRETE PAVEMENT

of this work was done by sluicing in material by means of a jet of water under pressure. The material available was not very well suited to the process, being an unusually pure blue clay, and the result has not been entirely satisfactory owing to the very long time required for the backfill to drain.

PERSONNEL—The preliminary designs for this dam and the surveys for the project of which it is such an important part were made by the writer. The detailed designs for the spillway and headgates were made by the Ambursen Hydraulic Construction Co.

H. Sidenius was resident engineer for construction of the concrete work, and has assisted in the preparation of this article. A. J. Raymond was Superintendent of construction. A. Fronhoefer, Division Engineer, was in charge of construction of the earth embankment and paving, and the excavation of the canal.

The work as a whole was under the direction of A. S. Dawson, Chief Engineer of the Department of Natural Resources, Canadian Pacific Railway Co., Calgary, Alberta.

## Regulation of the Opening and Restoration of Pavement Surfaces in Springfield, Ohio

BY GEORGE L. RINKLIFF*

Since the first of the present year, when the city of Springfield, Ohio, installed the commission-manager plan of government, much attention has been given by the city officials to the problem of street maintenance. One of the first steps of City Manager Charles E. Ashburner was the adoption of an economical and efficient system of street repairing.

Early in January, an investigation was conducted into the history of street repairing, as shown in the records of the city during the year 1913, and it was found that permits had been issued for nearly 800 trenches in improved streets, in addition to the openings made by public-service corporations. An examination of the streets, as well as the methods of backfilling and repaving, showed that practically every trench made during the preceding year was a potential chuck hole. The investigation showed the need for trench work to be due chiefly to two causes: one, the neglect of the city to complete the underground construction in streets before paving, and the other, the deterioration of mains and service pipes through electrolysis.

The plan adopted by the City Manager is intended first of all to make it unnecessary to open a paved street, except as an emergency measure, and to insure the restoration of the surface as satisfactorily as good workmanship makes possible. The assistance of the Bureau of Standards at Washington was secured in an effort to reduce the deterioration of underground metallic construction, and the public-service corporations operating electric-railway lines in and through the city have readily agreed to coöperate in the present plans of electrolytic mitigation.

*Administrative Department, City of Springfield, Ohio.

### Laws for the Preservation of Pavements

The present charter of the city of Springfield provides that after the paving of a street, no excavations can be made within a period of five years from the date of the completion of the work, excepting by permission of the city commission, in which four-fifths of the members concur. Following up the opportunity thus opened, it was decided to include in all resolutions of necessity, which constitute the first legislative step in street-paving procedure, a notice to the owners of property fronting upon the street to the effect that all sewer, water, gas and other connections must be installed previous to the commencement of the pavement-construction work; and that in the event of the failure of any property owner to comply with that notification, the city reserves the right to construct such connections, and assesses the cost against the property to be benefited.

Furthermore, it was decided that the paving of a street should not take place until every other form of improvement in the street had been provided. Previously, macadam streets had been torn up in a number of instances for the construction of sewers, and brick- and sheet-asphalt streets were trenched for considerable distances to install telephone, telegraph and electrical conduits. The new method of procedure calls for a study of the probable needs of a street in the way of underground construction during the life of the street paving, and the making of ample provision for the needs before the paving work starts.

### Restoration of Pavement

It was recognized, however, that these precautionary measures would not entirely eliminate the necessity for opening paved streets, and that the policy of street maintenance would not be complete without some provision being made to insure the restoration of the street surface, where trenches were made.

Cash Deposits—The city consequently decided to assume all responsibility for the repair of trenches in the future. An ordinance was passed, repealing the legislation previously in force, which had required persons opening paved streets to give bond for the satisfactory repair of the paving, and substituting therefore a provision for the issuance of permits for street openings only when deposits are made to cover the cost of the trench repair.

Permits—Plumbers and all others desiring to dig trenches in streets are required first of all to file an application in the office of the city engineer, upon a form furnished by the city for that purpose, stating the name of the applicant, the location and purpose of the opening, the length and depth of the trench, and the names of all persons interested, or to be benefited by, the work to be done.

The city engineer is required to prepare and to keep on file a schedule of the estimated cost of backfilling and resurfacing in various kinds of street paving, and from this schedule the amount of the deposit required is determined. The permit issued to the applicant contains all the information upon the application, together with a statement of the amount of the cash deposit, and the dates between which the opening may be made. The permits are numbered serially, and a daily report is made to the city auditor, showing the amount deposited for each permit, while the cash deposits are turned over to the city treasurer each day, and placed in what is known as the Special Repair fund.

Inspection of Underground Work—A carbon copy of the permit is turned over to a plumbing inspector who passes upon the quality of the work installed before the trench is backfilled. After having completed his work, the holder of the permit notifies the engineering department of that fact in writing, and after it has been ascertained that the plumbing inspector has approved the work so far as it has been completed, a postcard is mailed to the holder of the permit, notifying him that at 7 a.m. of a given day the city will assume responsibility for the trench. Until that time, the person or company holding the permit is responsible for barricades and red lights on the trenches.

Pavement Repairs—In backfilling the trench, the earth is firmly tamped, the street paving removed for a foot or so back from the edge of the trench and a new concrete foundation laid with its edges upon firm earth which has not been disturbed. The wearing surface is then added, and the work finally passed upon by an engineer.

The street-repair foreman makes a report to the chief engineer upon the cost of backfilling and resurfacing each trench, giving the expense for labor and material. This report is certified to the city auditor, who issues a warrant to the treasurer for a refund of any balance left in each deposit, or collects from the holder of the permit any amount in excess of his deposit, should the expense of backfilling be greater than the estimate. Should the holder of a permit fail to pay an excess charge, he would be refused any further permits.

Charges for Pavement Repairs—In the schedule showing the estimated cost of backfilling and resurfacing trenches, three classifications are made, according to the depths of trenches. The first classification includes all trenches of 30 in. or less in width, and 4 ft. or less in depth. The second classification includes all trenches between 4 and 7 ft. in depth, and restricts their width to 30 in. The third classification permits of a 40-in. width, and a 12-in. depth.

The charge per lin.ft. of trench in the various kinds of street paving, in each classification, is shown by the accompanying table:

TABLE SHOWING CHARGES FOR BACKFILLING AND RESTORING PAVEMENT

| Surface | First | Second | Third |
|---|---|---|---|
| Brick | $1.02 | $1.20 | $1.61 |
| Sheet asphalt | 1.34 | 1.52 | 1.74 |
| Asphalt block | 1.59 | 1.74 | 1.99 |
| Asphaltic concrete | 1.24 | 1.42 | 1.86 |
| Medina stone | 2.14 | 2.32 | 2.54 |
| Granite | 2.14 | 2.32 | 2.54 |
| Wood Block | 1.74 | 1.92 | 2.14 |
| 6-in. waterproof macadam (mixed) | 0.74 | 0.92 | 1.32 |
| 6-in. waterproof macadam (penetration) | 0.59 | 0.77 | 1.17 |
| 8-in. waterbound macadam | 0.44 | 0.62 | 0.97 |
| 8-in. gravel | 0.34 | 0.52 | 0.84 |

Special estimates are prepared for trenches not included in the general classification given above and charges made accordingly.

The plan appears to be satisfactory all around. The plumbers, some of whom at first objected, are now practically a unit in expressing their approval, as it relieves them of the necessity of keeping repair gangs. The public, previously dissatisfied with the condition of the streets, is at present waiting to see what the results of the new plan will be, but are not giving expression to any noticeable criticism.

# Water-Supply of Boulder, Colo.

By Clair V. Mann*

Few cities in the world have a water-supply drawn from so high an elevation and so pure and abundant as Boulder. The elevation of the sources is from 2 to 2½ miles above sea level. The character and location of the drainage area insures a high degree of purity. The average consumption (and waste) is seldom below 200 gal. per capita per day and in the dry summer months often reaches 400 gal.

Boulder, the seat of the State University of Colorado, is a city of 10,000 inhabitants, situated 29 miles northwest of Denver, and at the extreme eastern base of the foothills of the Rocky Mountains. The elevation of Boulder above mean sea level is 5350 ft.

The water-supply of Boulder is derived from the Silver Lake drainage area, 8.73 sq.mi. in extent, varying in altitude from 10,200 to 13,500 ft. above sea level, and lying at the crest of the Continental Divide, 20 miles due west of Boulder. The annual precipitation over the entire watershed averages from 40 to 45 in., the major portion of which falls in the form of snow from September to May, inclusive. A small portion of this snow, lying on southern slopes, is melted as it falls, or in the course of a few days or weeks. The remainder is piled by the strong westerly winds into enormous drifts in the crevices and deep ravines of the watershed, there to remain until melted away in the warm and sunny days of June, July and August. One of the drifts which so accumulates has never melted entirely away. It is, in fact, a true glacier, one of the very few now existing in Colorado. It is situated near the top of Arapahoe Peak, and is called the Arapahoe Glacier.

The minor portion of the annual precipitation falls as rain, hail or sleet, during June, July and August, and serves to augment the melting of the snows. As an example of the monthly distribution of precipitation, the accompanying record for 1911—a normal year—is given:

PRECIPITATION IN INCHES, SILVER LAKE WATERSHED, 1911

| Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5.85 | 6.20 | 7.60 | 7.90 | 1.70 | 1.20 | 4..5 | 2.12 | 2.79 | 2.50 | .... | 1[illegible] | 43.66 |

The percentages of runoff and of loss from evaporation have not been determined.

In the Silver Lake Watershed, there rise the north and middle branches of North Boulder Creek, otherwise known as Albion Creek and Arapahoe Creek, respectively. The normal flow of Albion Creek varies from 1 sec.-ft. or less in December and January, to from 20 to 25 sec.-ft. in June, July and August. The flow of Arapahoe Creek varies from 1 to 4 sec.-ft. in December and January, up to as high as 60 and 100 sec.-ft. in June, July and August.

Along the headwaters of each of the two branches of North Boulder Creek there lie (Fig. 1), at short distances from each other, 10 natural lakes, of glacial formation. Viewed from the top of Arapahoe Peak, these lakes, with their crystal-clear water and their setting of wild and rugged mountain peaks and dense pine forests, form a bit of scenery which, once seen, can never be forgotten. Fig. 2 is a view of the chain of lakes on Arapahoe Creek. The names are as follows: Triple Lakes, Goose Lake, Island Lake, and Silver Lake.

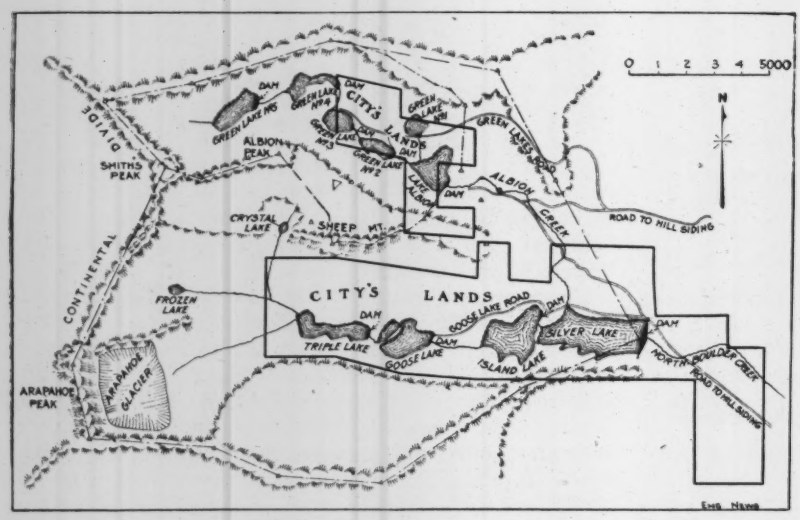



Fig. 1. Map of Water-Supply Drainage Area, Boulder, Colo.

In 1904, because of the pollution of the old source of supply—Middle Boulder Creek—with tailings and slimes from the mines and mills above the old Lower Intake, it became necessary for Boulder to seek a new source of supply above the region of possible pollution. The city purchased a number of the lakes in the Silver Lake Watershed, and acquired title, by special Act of Congress and otherwise, to a considerable portion of the lands within the watershed, and adjoining the lakes. Surveys were made at each dam site, and preliminary work was done in excavating outlet channels at each lake. The contemplated areas, capacities, and heights of the several reservoirs, together with the original estimates of the cost of development, were as follows:

| Reservoir | Area, acres | Capacity, acre-ft. | Height, dam, ft. | Cost |
|---|---|---|---|---|
| Triple Lakes | 37.5 | 662 | 40 | $10,000 |
| Goose Lake | 46.1 | 1036 | 30 | 30,000 |
| Island Lake | 51.9 | 1511 | 35 | 7,000 |
| Silver Lake | 109.0 | 3822 | 60 | 100,000 |
| Albion Lake | 38.4 | 1811 | 60 | 40,000 |
| Total | | 8842* | | $187,000 |

*Or 2,883,000,000 gal.

At the present maximum rate of consumption, this amount of storage (one year's filling) would be sufficient to last the city for two years.

To eliminate waste, and all possibility of pollution of the water enroute from the lakes to Boulder, a steel gravity pipe line was built in the summer of 1906. It is approximately 9 miles in length, and has its intake at the "Intake Reservoir," a point on North Boulder Creek, six miles below Silver Lake, at an elevation of 8200 ft. above sea level. This reservoir has a capacity of 9,300,000 gal. The lower end of the line discharges into the head-gate chamber of the old gravity pipe lines in lower

*Boulder, Colo.

Boulder Cañon, situated on Middle Boulder Creek at a point approximately three miles west of Boulder, and 5950 ft. above sea level. The pipe line consists of 3800 ft. of 12-in., 16,800 ft. of 15-in. pipe and some 27,000 ft. of 18-in. pipe, all pipe ¼ in. thick, lap-welded longitudinally. Joints are made with cast-iron bells, which receive the ends of two consecutive pipes. The points are calked with oakum and lead in the usual manner.

From the old intake of the lower Boulder Cañon pipe lines, the water is conveyed to the city through several thousand feet of 24-in. wood-stave and 20-in. cast-iron pipe and through a separate 15-in. steel gravity line. Sunshine and Chautauqua reservoirs serve to equalize the pressure on their respective distributary systems, which are operated separately and also provide some protection in case of a serious fire, or break in the main a failure to find suitable foundations within from 15 to 25 ft. of the depth indicated on the contract drawings, Mr. O'Brian refused to execute his contract, and on Aug. 20, 1912, the work was abandoned. Since that time, no further real progress has been made on the dam, but the city has done some prospecting and other preliminary work which should have been done in the beginning. In all, about $30,000 have been spent on the dam to date. At this writing, new plans for a rock-fill structure are under consideration, and it is expected that work will shortly be commenced in accordance with them.

No plans of a definite character have so far been made for dams at Island and Triple lakes, and it is probable that none will be made in the near future. For additional storage, an effort is being made to gain possession of the five Green Lakes lying above Lake Albion.

FIG. 2. CHAIN OF LAKES ON ARAPAHOE CREEK; PART OF WATER-SUPPLY OF BOULDER, COLO.
(Beginning in the foreground the lakes shown are named as follows: Triple, Goose, Island, Silver.)

supply-pipe lines. They have capacities, respectively, of 5,775,000 and 3,712,500 gal.

Since completing the Mountain Pipe Line, in 1906, the city has actively undertaken the development of its mountain reservoir system. In 1908, a timber crib dam 30 ft. in height, with loose rock fill, was completed at Goose Lake, at a total cost of $26,246. In June, 1910, active construction was begun on a 60-ft. cyclopean rubble-concrete dam at Lake Albion. This dam is now two-thirds complete, and to date has cost nearly $210,000. When complete, the dam will contain 17,315 cu.yd. of masonry.

In the summer of 1911, excavation was made at Silver Lake for the foundations of a rock-fill dam 35 ft. in height. A contract was subsequently let to the Peter O'Brian Construction Co., of Denver, for placing the rock fill, and otherwise completing the dam. Owing to

With the dams completed, which are contemplated or now under construction, and with the Mountain Pipe Line extended up North Boulder Creek to a point above the Denver, Boulder & Western Ry., the City of Boulder will have a water system of which it may well be proud, and which, in the semi-arid State of Colorado, will be worth at least $1,000,000.

The writer was Resident Engineer on the Albion Dam during the construction seasons of 1910, 1912 and 1913, and Inspecting Engineer on Silver Lake in the season of 1912.

**Russian Thistles Caused Breaks in the Irrigation Canals** of the Truckee-Carson Project in June, 1914, according to the United States "Reclamation Record" for July-August. The only information on the subject is:

The accumulation of Russian thistles in the canals formed dams in the structures and caused many breaks in laterals which kept the repair force busy. This nuisance decreased towards the end of the month.

# Motor-Truck Loading on Highway Bridges

By L. R. Manville* and R. W. Gastmeyer*

It is desired in the following article to call attention to the inadequacy of a large percentage of our highway bridges to accommodate the heavy automobile traffic of today. It appears to be a fact that automobile-truck designers are blindly turning out machines which neither ordinary highway bridges nor highway macadams will sustain.

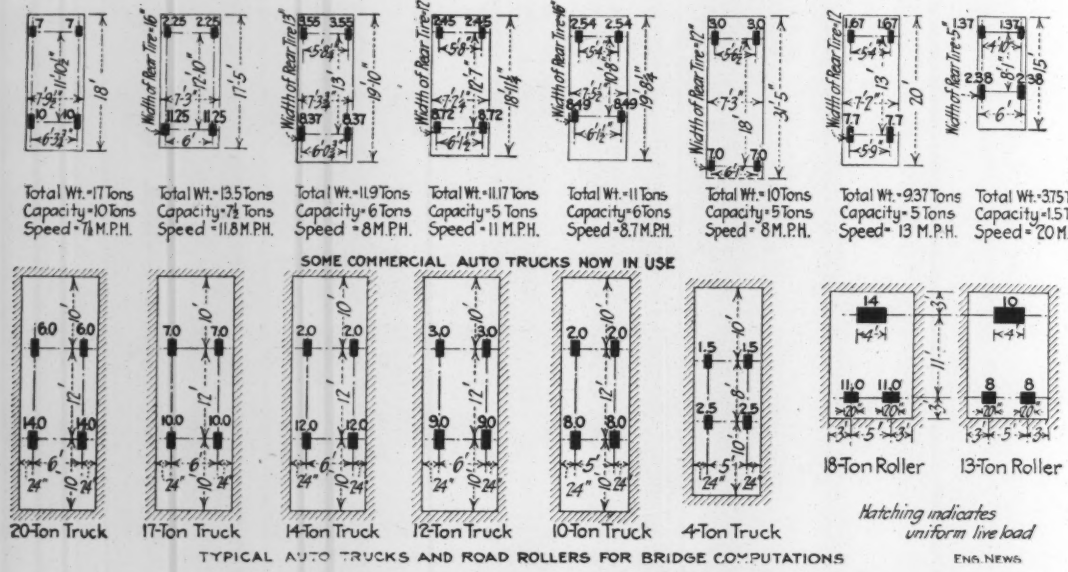
Recently, there have been several published reports of failures of highway bridges. These failures are causing railroads and other corporations, as well as states and municipalities, owning highway bridges for whose strength they assume the responsibility, to take an active interest in the weights of auto trucks being placed upon two rollers might be on a bridge at the same time was so remote that it was never deemed practical or fair to design floor-beams for that loading. Today it is a common occurrence that *two motor trucks pass* each other on a bridge.

Modern trucks traveling at the rate of 12 mi. per hr. can be stopped within a comparatively short distance; this sets up *longitudinal stresses* in the floor system. Further, where the planking is not adequately tied down the longitudinal forces may prove destructive to the floor surface.

Better *protection fences* must be given trusses to protect them against possibility of collision.

The trucks, traveling at a much greater speed than the rollers, produce *more jar and sway*, which require stiffer bracing.

*Centrifugal forces* will act on bridges occupying a




Load Diagrams of Auto Trucks and Road Rollers

the market. It is time that some one in authority call a halt to the excessive wheel-loads our modern trucks are imposing; or at least that the state authorities inaugurate the practice of posting signs on all highway bridges limiting the loads permissible, and at the same time regulate the concentrations permitted on state highways.

### Old Loadings and Modern Loads

The customary loading assumed for the design of a highway bridge in the past has been a certain uniform live-load alone, possibly a typical heavy wagon or road-roller, or a uniform live-load with a concentration. These types of loading, of course, had their origin at a time when traffic conditions were readily taken care of by such assumed loads. But *these older types of loading are inadequate for purposes of design to take care of modern conditions*; they should be replaced by some types of typical motor trucks. Many auto trucks now give greater axle concentrations than any roller heretofore used, and with less favorable distribution.

Other Effects of Motor Trucks—The chance that sharp bend in the roadway, an effect which was negligible with slow-speed rollers.

Thus, many conditions arise which have heretofore never been encountered in simple highway-bridge design. What is more, trucks are frequent in their passage, while rollers came along quite infrequently, and as a result we have not merely occasional overload but a daily repetition of the overloading.

### Comparative Figures on Trucks and Rollers

Accompanying this article is a diagram showing concentrations and wheel spacing, as well as outside dimensions of various trucks which are being sold today. From these examples, certain typical trucks are recommended to be used for designing new bridges as well as for investigating old bridges. It should be noted that the area assumed as covered by the typical trucks is based on the idea that the truck is in motion; possibly more than 32 ft. in the direction of traffic would be justifiable, but the distance is at least a conservative one.

The table accompanying shows the comparison between trucks representing actual present-day operation and two common types of road rollers, 13 ton and 18 ton, used

*Structural Department, New York Central R.R.; Grand Central Terminal, New York City.

COMPARATIVE BRIDGE MOMENTS FROM ROLLERS AND AUTO TRUCKS

Maximum moments in thousand foot-pounds for a width of bridge equal to the width of roller or truck.
Impact is included as follows:
For rollers, $\frac{25\%}{150}$
For trucks and uniform load, $\frac{150}{L + 300\%}$ where L = loaded length in ft.

Trucks assumed to be surrounded by uniform live-load of 100 lb. per sq.ft. for spans over 15 ft.; rollers without uniform live-load except for floorbeam moments of 18-ton roller.

Figures in parentheses ( ) are ratios $\frac{\text{Load or moment from truck}}{\text{Load or moment from 13-t. roller}}$

Figures in brackets [ ] are ratios $\frac{\text{Moment from truck}}{\text{Moment from uniform L.L.}}$

| TYPE OF LOADING | | 20-ton truck | 17-ton truck | 14-ton truck Dump-cart type | 10-ton truck | 13-ton roller No U.L.L. | 18-ton roller No U.L.L. | Uniform Live-Load |
|---|---|---|---|---|---|---|---|---|
| WHEEL CONCENTRATION | | 14 (1.75) | 10 (1.25) | 12 (1.5) | 8 (1.0) | 8.0 | 11.0 | |
| MOMENTS | Span, ft. | | | | | | | |
| | 10 | 104 (2.08) | 74 (1.48) | 89 (1.78) | 59 (1.18) | 50 | 69 | 21 |
| | 12 | 124 (2.08) | 89 (1.48) | 107 (1.79) | 71 (1.18) | 60 | 83 | 29 |
| | 15 | 155 (2.07) | 111 (1.48) | 133 (1.78) | 89 (1.19) | 75 | 103 | 45 |
| | 20 | 206 (2.04) | 147 (1.45) | 176 (1.74) | 118 (1.17) | 101 | 138 | 81 |
| | 30 | 343 [1.90] | 262 [1.45] | 279 [1.54] | 191 [1.06] | 180 | 246 | 181 |
| | 40 | 509 [1.61] | 405 [1.28] | 405 [1.28] | 287 [0.91] | 260 | 356 | 317 |
| | 50 | 696 [1.42] | 572 [1.16] | 550 [1.12] | 400 [0.82] | 340 | 469 | 492 |
| | 60 | 913 [1.30] | 768 [1.10] | 725 [1.04] | 540 [0.77] | 421 | 581 | 701 |
| FLOOR-BEAM MOMENTS (10-ft. panels) | Width, ft. | | | | | | 18-ton roller with U.L.L. | |
| | 15 | 106 (2.04) | 78 (1.50) | 93 (1.79) | 71 (1.37) | 52 | 76.5 | |
| | 20 | 169 (2.22) | 128 (1.69) | 134 (1.76) | 115 (1.51) | 76 | 122.8 | |
| | 25 | 243 (2.36) | 188 (1.82) | 216 (2.10) | 169 (1.64) | 103 | 178 | |
| | 30 | 327 (2.60) | 257 (2.04) | 291 (2.31) | 232 (1.84) | 126 | 242 | |

in designing bridges. While the uniform live-load is generally omitted in design when using a roller (except possibly when an 18-ton roller is used on city bridges), the writers feel justified in using a uniform live-load of 100 lb. per sq.ft. as a possible load that might be present simultaneously with the trucks.* There are several reasons for this assumption: three or four inches of well packed snow or ice would give 15 or 20 lb. per sq.ft.; timber might be piled alongside of the roadway for repairing an adjacent roadway and sidewalk; the assumption of a uniform load provides for all other traffic —such as trailers, if the truck is being used as a tractor, or a horse team near the truck; and, in general, the practice of using the uniform live-load simultaneous with the concentrations serves as a load factor-of-safety.

The moments in the accompanying table are for a width equal to the assumed width of truck or roller. *The moments include impact,* taken as 25% of the live-load in the case of the roller, and 150 $(L + 300)$ in the case of the motor truck, $L$ being the loaded strength of span in feet.

From this table, it is readily seen how these trucks are loading most bridges considerably beyond the loads employed in design. Considering the elastic limit of steel as about 32,000 lb. per sq.in., and our designing stress at 16,000 lb. per sq.in. in tension, it can be seen (from the columns showing ratios of moments of the trucks and rollers) how near the elastic limit a great many bridges are being worked. Especially is this true of the floor-beams and stringers, where the ratios of actual loads to designing loads run high, and it should be borne in mind in examining the table that the truck moments on the floor-beams do not take into account the case of two trucks passing.

While in the table of comparative moments a higher impact percentage has been used in figuring the trucks than in figuring the rollers, yet the moments produced by the trucks are so great that they would still be excessive if the impact effects were reduced to those employed for the rollers. It must be remembered that the roller was a slow-moving load and the resulting impact stresses were accordingly low; 25% of the live-load ought to cover the impact effect for an ordinary roller. The modern truck is capable of operating at a rate of about 12 mi. per hr., and the driver seldom if ever slows down the machine when on a bridge. An impact allowance of 50% would probably be required to cover the resulting stresses. The jar caused by these heavy trucks is often felt in houses set far back from the street, even when the pavement is asphalt in good condition, and the corresponding effect on a steel bridge can readily be imagined.

In the course of an investigation of the strength of a series of old highway bridges using truck loads similar to those given in the tables, it was found that the older bridges were not designed with uniform strength throughout to take care of the loads of today; and no doubt these old highway bridges referred to are typical of highway bridges in general. The floor-beams and stringers often are found to be considerably weaker than the main girders or trusses. The increase in loading due to the trucks shows most on the floor-beams and stringers because of the large percentage of load concentrated on the rear axle,* and the capacity of the bridge is largely limited by these members.

## Recommendations

Posting Capacity of Existing Bridges—Since the older bridges are now carrying loads considerably in excess of the loads for which they were designed, and since the modern loads introduce new forces on our bridges in the way of impact, centrifugal forces, braking effects, etc., it is urgently desirable as a safety provision that bridges be posted for their permissible loading.

Posted signs at the approaches of highway bridges should state the heaviest total weight of loaded truck permissible. Drivers should know the weight of their trucks empty, the amount of load on the heavier axle, and the total capacity. As a rule, drivers lack this essential information.

Loadings for Future Design—For future designs some departures must be made by engineers to conform to the modern conditions. The following requirements are suggested:

*Class A* bridges to be designed for a 20-ton truck as per diagram, surrounded by a uniform live-load of 100 lb. per sq.ft., to take care of heavy city traffic.

*The uniform live-load is considered as loading the clear roadway only on the area surrounding that assumed as occupied by the moving truck. For spans exceeding 60 ft. in length this uniform live-load could be materially reduced in amount.

*In the case of dump carts, over 80% of the total load is usually on the rear axle.

*Class B* bridges to be designed for a 12-ton truck as per diagram, surrounded by a uniform live-load of 100 lb. per sq.ft., to take care of suburban and state-road traffic.

*Class C* bridges to be designed for a 6-ton truck with distribution of load on axles similar to those shown, surrounded by a uniform live-load of 80 lb. per sq.ft., to take care of light country traffic.

If the clear roadway is wide enough to permit two trucks to pass, the floor system should be designed of corresponding strength; roadways over 16 ft. wide in the clear would come under this provision.* Class A and Class B bridges should provide for specified trolley loads in localities where such loads prove heavier than the truck loads. The bracing on these bridges should be effectively riveted stiff members. The planking should be well anchored and the floor-beam should be amply braced against stresses induced by sudden braking. All connection details should be worked out so that bracing members will prove efficient against vibration and lateral sway.

The dump truck will always require a heavy floor system if the scheme of dumping from the rear is adhered to, because of the large percentage of load balanced over the rear axle. Some form of center or side dump could be devised which would give more favorable concentrations for floor-beam and stringer design.

Class B loading should prove ample for almost any truck, and it is recommended as the most generally applicable type of loading. It should prove satisfactory for the *occasional* operation of any of the heavier types of trucks. A bridge designed for two Class B trucks passing each other will not be much heavier than most Class B bridges designed under the older types of loads, and the weight will be much better distributed to give a bridge of uniform strength throughout.

### Future Increase in Truck Loads?

After all, the above loads will not take care of all possible increases in highway loads unless legislation is enacted limiting load concentrations. There might be no limit to these concentrations if truck manufacturers are permitted to continue unrestricted. This would appear to be a matter of State regulation and surveillance. To blindly design bridges to take care of uncalled-for future increases in loading would involve a wasteful expenditure of money; and railroads and other corporations owning bridges, and finally the taxpayers, would be the ultimate losers.

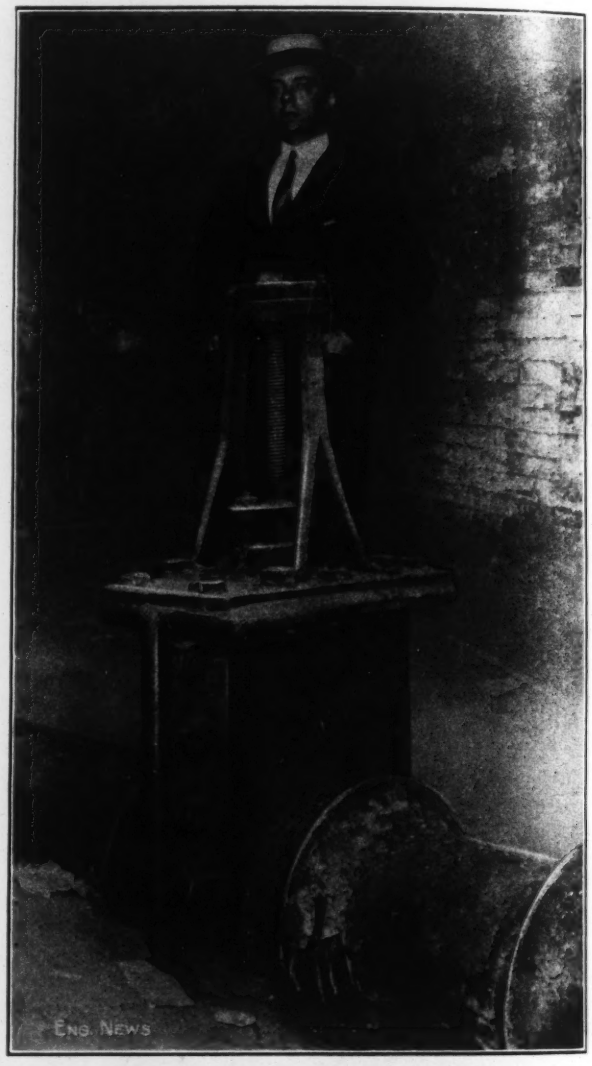
*Higher unit stresses may be used for floor-beams in the case of two trucks than would be safe under the normal single load, because the double load is of relatively rare occurrence.

## A Bit of Early American Water-Works' Equipment

An old gate valve which was a part of the appurtenances of the old cast-iron water-storage tank of the Manhattan Co., New York City, described in Engineering News of July 23, is shown in the accompanying illustration. We have been unable to obtain any exact information as to the time this valve was installed, but if it was as old as the tank, it dated back to the beginning of the last century.

The body of the valve was of cast iron; the stem, yoke rods and bolts of wrought iron; and the gate itself was a sheet of cast-iron, connected to the screw stem by a loose link. Although all the company's street mains were of wood—bored logs, yet the tank fittings were all cast iron.

Cast-iron water pipes were made and used for some purposes as early as the middle of the 18th century, but curiously enough were objected to for mains carrying a potable water supply as unhealthful. In the latter part of the 18th century and the first part of 19th century, when the London water pipes began to give out because of increased pressures, it was proposed to substitute pipes of bored stone for the wood mains, as the popular clamor against iron pipes was formidable. Patents were granted to two or three inventors for stone-pipe boring machines, and considerable money was invested in the industry.



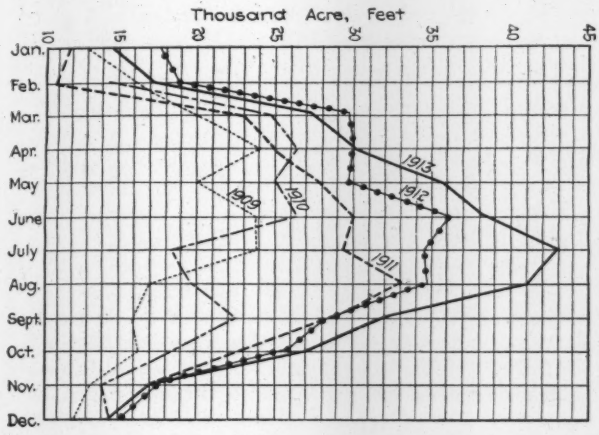

Early Water-Works Gate-Valve

For the photograph shown we are indebted to Alfred D. Flinn, Deputy Chief Engineer of the Board of Water Supply of the City of New York. Mr. Flinn and other officials of the Board of Water Supply probably would have liked to see the old valve preserved in some museum as a relic of the city's history, but the city's historical societies could not be interested in a mere engineering curiosity, and the old valve was broken up for junk.

# Irrigation Operations of Imperial Water Co. No. 1 for the Year 1913

Intensive cultivation on land below sea level in what only a few years ago was a sun-parched desert has been made possible by diverting the water of the Colorado River into that portion of the extreme southern portion of California which is now known as the Imperial Valley. Water for this district is supplied wholesale by the California Development Co. to a number of companies which distribute it to farmer's canals. We have received from Ray S. Carberry, Superintendent of Imperial Water Co. No. 1, a copy of his annual report for the year 1913 and have taken from the report a number of unusually interesting and valuable operating and cost facts and figures.

The company operates 330 miles of canals. These canals cover 115,520 mi. of irrigable land. During 1913




MONTHLY DELIVERIES OF WATER TO THE IMPERIAL WATER CO. NO. 1 FOR THE YEARS 1909 TO 1913, INCLUSIVE

the company executed 33,964 orders for water and paid the parent company for 337,349 acre-ft. of water, which was delivered to 101,796 acres of crops. On this work an average of 172 men were employed per day for a working year of 300 days.

The accompanying diagram shows the amount of water delivered to the company by months during the past five years. The maximum demand in 1909 and 1910 was in April, but since then it has ranged from June to August. In 1913, July was the maximum month.

Unaccounted-for water in 1913 amounted to 11.06%, which was the difference between the measured amount received by the company and the measured quantities delivered to individual consumers. For earlier years the unaccounted-for water was as follows: 1912, 13.9%; 1911, 15.9%.

The 11.06% of water not accounted for in 1913 represented a gross charge against the company of $20,737, reduced to $1996 by an allowance of 10% on the part of the parent company.

The difference between what may be termed the wholesale and retail deliveries is explained in Mr. Carberry's report as follows:

The difference of $20,737.47 may be accounted for in seepage, evaporation, waste, stock water and error in measurements, of which the waste water is a principal factor in crowding our ditches during the peak load, which results in considerable overflow of the banks, occasioned by the stockholder's ditch, as well as the company's ditch, being in an undesirable condition for conveyance of the maximum amount of water at that time of the year.

Your Board, by authorizing the charging for stock water, has saved several dollars; not that the charge for any large amount was made, but the fact that stock water was charged for reduced materially free irrigation under pretense of stock water.

The errors of measurement will be further investigated and studied in hopes that some further information may be given to you relative to this condition.

Cost figures for cleaning canals, clearing canals, cutting brush, widening and shaping banks, "Canal V'ing," dredging and for automobiles are given in the report as follows:

CLEANING CANALS—During the year we cleaned 339 mi. of canal, at a cost of $35,826, or $105.68 per mi., as compared with 343 mi. of canal at a cost of $88.61 per mi. for 1912, or 465 mi. at a cost of $60.64 in 1911, or 562 mi. at a cost of $43.81 per mi. in 1910. The gradual increase of cost may be attributed to the increased amount of material necessary to be removed by cleaning occasioned by increased capacity required at such times as the increased quantity of silt, growth and difficulties of labor conditions, effect this class of work.

CLEARING CANAL on 50 miles cost $1984, or $38.68 per mi., as compared with 101 mi. at a cost of $80.58 per mi. in 1912, or 194 mi. at a cost of $35.39 per mi. in 1911. This decrease is accounted for by the fact that little clearing and more cleaning has been done, therefore increasing the cost of one and decreasing the cost of the other.

CUTTING BRUSH on 300 mi. of canal cost $1054, or $33.51 per mi., as compared with 200 mi. at a cost of $18.98 per mi. in 1912, or 392 mi. at a cost of $20.71 per mi. in 1911, or 346 mi. at a cost of $43.45 per mi. in 1910. The increase per mi. in this class of work is attributed to the fact that considerable heavy growth was cut during the year that had not been attempted during the previous years.

DISC AND GRADER—During the year we have continued the use of disc and grader outfits on our canal banks, with the result of widening the banks, removing the "V" rolls, discouraging the growth, and in some places making the banks suitable for travel, and for the use of mowing machines to keep down the growth. This work during the year has cost $4851 in covering 296 mi. of canal, or $16.39 per mi., as compared with 280 mi. at a cost of $14.88 per mi. for the previous year.

CANAL V'ING still proves the best method for cleaning the canals where same is practical. The detailed amounts and costs of this work are as follows:

| | 1910 | 1911 | 1912 | 1913 |
|---|---|---|---|---|
| Total cost | | $21,437.78 | $26,142.08 | $26,471.20 |
| No. of miles of ditch V'd | 362 | 364 | 481 | 431 |
| Cost per mi. for V'ing | $25.94 | $16.76 | $17.05 | $21.99 |
| Cost per mi. repairs to engine | 15.66 | 16.29 | 13.43 | 14.31 |
| Cost per mi. repairs to V's | 5.56 | 5.09 | 3.93 | 2.38 |
| Cost per mi. fuel and oil | | 5.96 | 6.52 | 6.69 |
| Cost per mi. Mexican labor | 13.58 | 14.80 | 13.42 | 16.04 |
| Total average cost per mi. | $60.74 | $58.91 | $54.35 | $61.41 |

DREDGING—During the year the Stockton dredges and the Austin dredge, referred to in my report of a year ago, have been practically in continual operation. On the first of August an additional Stockton dredge as purchased, which also had been in continual operation since that time. During the latter portion of the year a contract was made with the Schlatter Dredge Co. for experimental work with their dredge at 15c. per yd.

As this method of work is comparatively new, it may be of interest to note that the Stockton dredges have worked on 37.3 mi. of canal and excavated 188,708 cu.yd. of material at a cost of 10.7c. per yd. Austin dredge worked on 33½ mi. of canal, removed 96,712 cu.yd. of material at a cost of 16.8c. per cu.yd., to Water Company No. 1, while the Schlatter dredge worked on four miles of canal, removed 3862 cu.yd. of material for 15c. per cu.yd. The total mileage for the year for these dredges amounts to 74.8 mi., total yards for these dredges for the year amounts to 287,282 cu.yd. and total cost to Imperial Water Co. No. 1 is $37,150.98, or 12.93c. per cu.yd.

The repairs on the Stockton dredges have amounted to $1353 for operating 17 months, or $79.40 per month, which is quite nominal compared with repairs needed for caterpillar engines. It is certainly a question as to how we would have been able to deliver water throughout the past year had not this 287,282 cu.yd. of material been removed.

From the foregoing you will note that we have worked on 1491 mi. of canal in 1913, as compared with 1438 mi. in 1912, 1415 mi. in 1911, while our statement shows but 330 mi. in our system, this gives you some idea of the amount of work required to maintain the delivery of water as long as the peak load remains in the latter part of the summer.

AUTOMOBILES—During the past four years we have used three cars and they have traveled 66,331 mi., the cost of same may be divided as follows:

| | Overland cars 1910 | Overland cars 1912 | Hupmobile |
|---|---|---|---|
| Purchase price | $1,275 | $1,100 | $829 |
| Miles run | 19,447 | 22,858 | 24,026 |
| Gasoline consumed, gal. | 1,966 | 1,844 | 1,461 |
| Total repairs | $1,123 | $800 | $540 |
| Total operating cost | 1,860 | 1,411 | 1,027 |
| Operating cost per mi. | 0.0956 | 0.0617 | 0.0425 |
| Total expense | $3,284 | $2,413 | $1,913 |
| Total cost per mi. | 0.1688 | 0.1054 | 0.0796 |
| Average mi. per gal. of gasoline | 9.89 | 12.39 | 16.44 |
| Average cost per mi. for casing | 0.0225 | 0.0187 | 0.0128 |
| Depreciation on car per mi. of travel | 0.0511 | 0.0250 | 0.0243 |

The distribution of irrigation costs for the past three years and the acre-ft. of water delivered and the cost of water per acre-ft. were as follows:

The acreage of crops in 1913 was 101,796, divided es follows: Alfalfa, 59,279; barley, 19,257; corn, 12,-933; cotton, 4741; melons, 3125; vineyard, 910, asparagus, 361; truck, 86; miscellaneous, 1104.

The increased amount of water used per acre of crop, as shown in the table, is "attributed to the increase in summer crops and the decrease in winter crops, more alfalfa, corn and cotton and less barley."

| | 1911 | 1912 | 1913 |
|---|---|---|---|
| Canals | $94,756.14 | $98,795.82 | $86,[illegible].82 |
| Dredging | ..... | ..... | 3[illegible].61 |
| Distribution of water | 23,458.81 | 25,352.54 | 2[illegible].76 |
| Live stock, etc. | 7,664.63 | ..... | [illegible].68 |
| Salaries, general | 12,443.35 | 13,275.28 | 1[illegible].67 |
| Engineering | ..... | ..... | 4[illegible].96 |
| Zanjero houses and phones | 1,850.39 | 2,187.58 | [illegible].64 |
| Tools and repairs | 1,386.10 | 1,784.81 | 3[illegible].53 |
| Expense, general and miscellaneous | 7,948.33 | 8,688.75 | 8[illegible].45 |
| Structures | 10,423.80 | 8,367.90 | 8[illegible].26 |
| Equipment, new | ..... | ..... | 11,[illegible].82 |
| Total | $159,931.55 | $158,454.68 | $198,[illegible].20 |

COMPARATIVE COST FOR PAST FOUR YEARS

| Year | Total cost | Acre-ft., delivered | Cost per acre-ft. delivered, cents | Acre-ft. per acre* |
|---|---|---|---|---|
| 1910 | $174,645.11 | 236,361 | 73.8 | 2.38 |
| 1911 | 159,931.55 | 274,665 | 58.2 | 2.758 |
| 1912 | 158,454.68 | 318,122 | 49.8 | 3.159 |
| 1913 | 198,946.20 | 337,349 | 58.9 | 3.314 |

*This column has been added here, using figures given elsewhere in the report.—Ed.

We are informed by Mr. Carberry that he will gladly mail copies of his complete report to any engineer requesting him to do so.

# Worcester Water-Works Plant and Operating Methods

*SYNOPSIS—The city of Worcester, Mass., does all its water-works construction, repair and maintenance by municipal day labor. In this article is a description of the organization, plant and operating methods, together with notes on local water-works practice, etc; two independent bureaus of the Water Department, one under a Water Commissioner and one under a Water Registrar; work of the 12 divisions under the Water Commissioner; work of the Water Registrar's bureau; regulations governing the use of water; shop, stables and yards; use of cement-lined service pipes; special service boxes, etc.*

The city of Worcester, Mass., is notable because for many years it has constructed practically all its public works by municipal day labor. Yet there is no public-works organization as a whole; there are a City Engineering Department, Street Department, Sewer Department, Water Department, each independent. Aside from the actual survey work and work preliminary to construction, the City Engineer acts merely in an advisory capacity, and has no power to enforce his recommendations. Each department works out its own problems largely in its own way. Some of those met and solved by the Water Department are given in the following columns.

The population of Worcester served with city water is about 166,000. The total annual consumption of water is about 4½ billion gallons, about 80% of which is metered. The average daily consumption is nearly 12,-000,000 gal., and the per capita consumption is about 72 gal. per day. The whole cost of supplying water, including maintenance and interest, runs about $66 per million gallons. The supply comes from several reservoirs by gravity; there are no pumping stations.

## Organization of the Water Department

There are two independent bureaus of the Water Department, one under the Water Commissioner, George W. Batchelder, which has charge of reservoirs, distribution system, operation and maintenance; the other bureau is under the Water Registrar, George C. Hunt, and looks after the reading of meters, collection of water rents, etc. The organization of the bureau under the Water Commissioner is shown in the accompanying sketch, Fig. 1.

All orders given in this bureau must have the approval of the Water Commissioner. Acting under the direction of the Water Commissioner, the General Foreman has supervision over Divisions 1 to 9 inclusive, shop and emergency calls, stock and supplies, pipe yard, service pipes and stop boxes; fire pipes and hydrants; repairs; hydrant inspection; shop accounting and construction. Foremen in charge of Divisions 10, 11 and 12, meter repairs, fire-pipe inspection and reservoirs, receive their instructions and make their returns directly to the Water Commissioner.

## Work of the Various Divisions

Each division is in charge of a foreman who acts under the orders of the Water Commissioner, as transmitted to him directly or through the General Foreman. A list of the various divisions, their work and the approximate number of men employed in each, follows:

Division I—Shop and Emergency—This division includes the shop and emergency crews, except as otherwise provided for. The force employed is about 25 men. Emergency calls are here taken care of, and the subforemen act under orders of the division foreman and report to him, day or night, any serious disturbance in the distribution system, such as sudden drops in pressure, reported leaks, broken hydrants, etc.

Division 2—Stock and Supplies—This division has charge of all stock and supplies at the East Worcester St. yard, which is adjacent to and part of the shop and stable layout. The division foreman furnishes all supplies when presented with properly signed requisitions, and is held responsible for the contents of stock room and yards. The men employed in this division are included in the 25 listed under Division 1.

Division 3—Pipe Yard—All the large pipe, fittings,

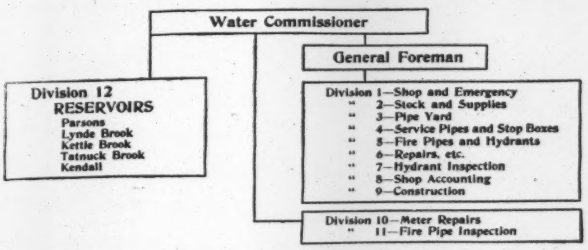



Fig. 1. Organization Scheme, Worcester, Mass., Water Department

gate valves, specials, etc., are unloaded directly into dump cars and stored in the Albany St. yard, which is about a quarter of a mile from the other material yard, shop and stable. About $130,000 in stock is here kept constantly in hand. This yard is in charge of a subforeman who keeps in touch and is answerable to the foreman of Division 2. There are about five men employed in Division 3.

Division 4—Service Pipes—All installations of service pipes, small pipe extensions, resetting and regrading of service and stop boxes made necessary by street changes, and such other work as may be directed, are performed by this division. The whole force of the division is about 30 men, divided into five gangs, each in charge of a subforeman.

Division 5—Fire Pipes and Hydrants—This division has charge of installing fire pipes, elevator pipes, fire hydrants, standpipes, flushing hydrants, drinking fountains and watering troughs, and has charge of the maintenance and repair of all these except drinking fountains and standpipes. The division force is about 18 men, divided into three gangs, each under a subforeman.

Division 6—Repairs and Maintenance—This division has charge of all general repairs to service pipes, drinking fountains, standpipes, service shutoffs, removing and replacing meters, etc. The force consists of 10 men in two gangs, each under a subforeman.

Division 7—Hydrant Inspection—Five men have the work of inspecting, maintenance and minor repairs to fire hydrants.

Division 8—Shop Accounting—The men in this division, four in number, are included in the force under Division 1. This division has charge of all accounts kept at the East Worcester St. shop and yards, and is in reality a subdivision of Division 1, although its chief is responsible only to the Water Commissioner and General Foreman.

Division 9—Construction—All construction work, and this includes construction work on reservoirs and new reservoirs, the installation of mains, replacements, repairs, maintenance, etc., employing 150 men, is done by this division, under four general foremen. The department owns an Austin trenching machine, the work of which was referred to in Engineering News, Aug. 6, p. 312, and numerous other uptodate equipment, which is used by the construction division.

Division 10—Meter Repairs, Light Machine Work, Etc.—This division has charge of the testing and repairing of all meters, which employs three men. The meters are installed by the employees of Division 4, as a part of the service connection. The house inspection and reading of meters is done by the men under the Water Registrar, as hereafter described. The meter-repair division makes tests of all new meters delivered at the shop, and makes necessary repairs to all meters taken off of services for any cause. The foreman keeps a careful record of all meters received at and delivered from his division, and sends copies of these records to the office of the Water Commissioner.

Division 11—Fire-Pipe Inspection—This is a one-man division, although he may have assistants assigned when necessary. He sets all small meters on fire-service lines, has charge of all inside valves on fire-protection services, reads and inspects meters on fire-service pipes, the Venturi meters at reservoirs, and has entire charge of the inspection of fire-service pipes. He makes daily reports direct to the Water Commissioner.

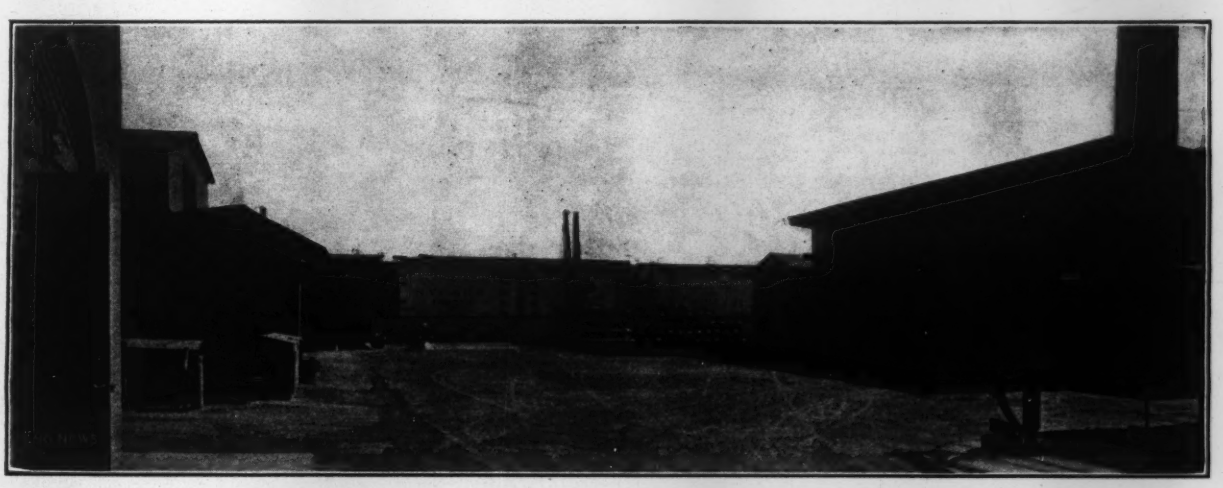


Fig. 2. Stock Yard on East Worcester St.; Tool Houses and Sheds

DIVISION 12—RESERVOIRS—This division includes the caretakers or foremen in local charge at the various reservoirs, each of whom reports direct to the Water Commissioner.

GENERAL—Under the General Foreman are three men detailed to make general emergency repairs. There is also a spare foreman ready to take the place of any regular foreman, assume emergency duties and perform any service he may be directed to by the Water Commissioner or General Foreman. Every man in the department is assigned to one or the other of these divisions and takes orders from the foreman in charge of that division. This, in general, is the rule of the organization, yet in cases of emergency all men are expected to carry out such directions as may be given them by the Water Comissioner, General Foreman, or such foreman as shall be in charge at the time.

### BUREAU OF THE WATER REGISTRAR

This bureau is locally called the Water Income Division of the Water Department. The bureau employs six meter readers and two inspectors. Every meter is read once a month. The meter readers are employed every working day in the year in reading meters, and each is held personally responsible for the condition of meters in his territory. The reader makes returns of the meter readings to the office each day, and he also posts the readings on a card on the premises of the owner, so that the owner may always know the quantity of water he is consuming each month.

The inspectors duties are to inspect the fixtures in houses where monthly consumption is out of the ordinary. Each day the readings turned into the office by the meter readers are examined in the office, and, if the consumption of any house is much in excess of the average, and there appears no reason for the increase, an inspector is immediately sent to examine the house-service fixtures. If the fixtures are found imperfect, the owner is immediately notified of the exact condition, thereby being able to take advantage of this information if he desires.

The city has at present about 18,000 meters. As Mr. Hunt says, the financial success of a water department depends largely upon the accuracy of the water meters and it is of the greatest importance that the meters be examined and tested frequently. About 3000 meters are taken out each year and repaired at the expense of the Water Department, unless they have been injured by frost or otherwise through negligence of the property owner. If the meter is worn out, a new one is installed at the expense of the owner. The total cost to the department of meter repairs in the year 1913 was $10,315.

### REGULATIONS GOVERNING USE OF WATER

There are the usual ordinances governing the introduction and use of water, all applications being sent to and handled by the office of the Water Registrar. All service pipes and appendages laid in the street are furnished and maintained by the city. From the street line to the outlet of the meter on the house side of the stopcock all pipes and fixtures are furnished, placed and repaired by the city at the expense of the owner. Bills for metered water are payable semiannually, in March and September. If bills for water or fixtures are not paid within 40 days after notice, the water is shut off and an additional charge of $2 made. Water users are charged $2 for shutting off and letting on water, when making repairs on premises, or for any other reason. All injuries to service pipes, street mains, hydrants, or other fixtures caused by ex-

FIG. 3. SHOP AND STABLE, WORCESTER, MASS., WATER-WORKS

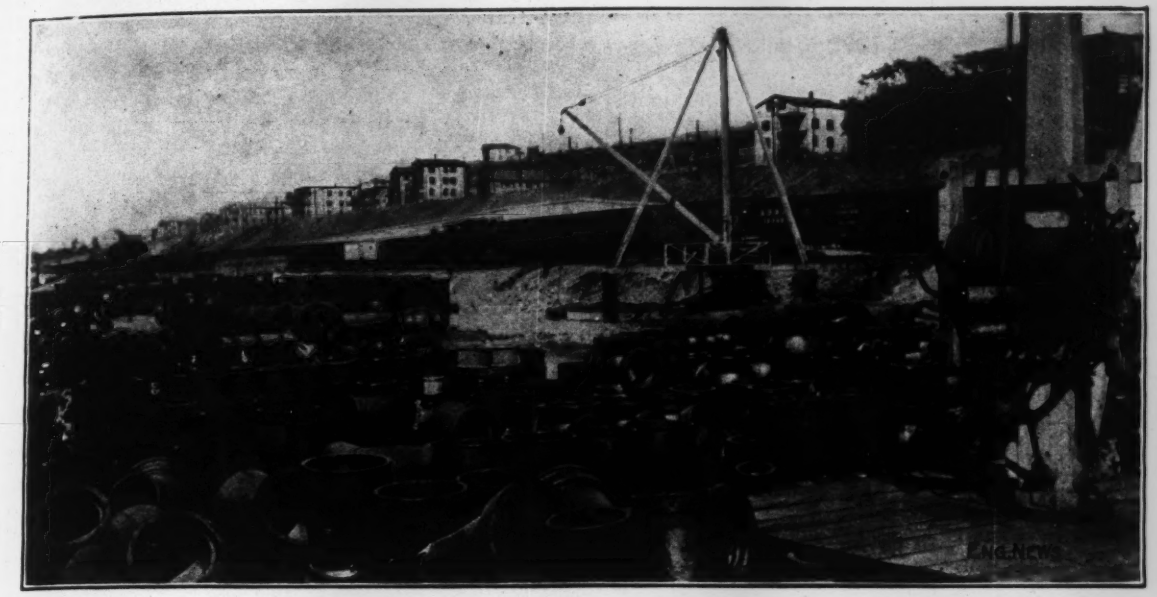


FIG. 4. ALBANY ST. STOCK YARD, WORCESTER, MASS., WATER-WORKS

cavations in putting in sewers, drain, or other pipe are charged to the owner of the premises for whom the work is done. Installing meters is optional with the owner. All private fire services are metered at the expense of the owner.

### SHOP, STABLE AND YARDS

Fig. 2 shows the East Worcester St. yard of t' e Water-Works Department. On the right are wagon and automobile sheds and on the left a row of individual tool houses, one for each service pipe gang. The corner of the building on the right is the stable and on the left the shop. Fig. 3 is a view of the shop and stables taken from the rear of the yard. Fig. 4 shows the Albany St. stock yards.

The shop was built in 1908 and is a thoroughly up-to-date water-works repair plant in every respect. On the first floor are the offices, general shop and storage room for tool chests, etc. On the second floor are the meter repair shop and the meter-testing room. Fig. 5 shows the interior of the meter repair shop, which is equipped as shown with lathes, drills, grindstone, etc., for light ma-

FIG. 5. INTERIOR OF METER REPAIR SHOP, WORCESTER, MASS., WATER-WORKS DEPARTMENT

FIG. 6. STOREROOM, WORCESTER WATER-WORKS SHOP

chine work. On the third floor are carpenter and woodworking shop and storerooms. The fourth or top floor is all storeroom, as shown in Fig. 6. Everything is orderly and well arranged as may be judged from the illustrations, which were taken under the direction of one of the editors, without previous warning to the shop foreman.

In the basement are additional machine tools and equipment for handling, repairing and storing the heavier appurtenances. From this basement of the shop there is a subway to the basement of the stable, which is utilized as a storeroom for service pipe, cocks, connections, hydrants and hydrant parts, etc., as shown in Fig. 7. Here is kept emergency repair equipment for serious breaks.

On the main floor of the stable overhead is a garage, as most of the vehicles now used by the Water Department are motor-driven. There are eight motor vehicles in all, two touring cars, one runabout, one 3-ton truck and four smaller trucks like the one shown in Fig. 3.

These small trucks are used for emergency work, but to be always ready to answer hurry calls the emergency wagon shown in Fig. 8 stands with harness ready to drop in place. This wagon is equipped with various kinds of apparatus for shutting gate valves, and making hasty repairs, lanterns, tools, etc. To answer these emergency calls, a crew of five men is always on duty, working in 8-hr. shifts.

The apparatus for quick closing of main gate valves consists of a rod wrench, which is put down the manhole, a wrought-iron frame fitting in the manhole opening, with a center ring to hold the wrench rod, and an ordinary wagon wheel which fits over the top of the wrench rod. The valve can be closed very readily and very rapidly by turning the wagon wheel.

Over the main floor of this building is the stable proper which is now used by but one or two horses.

## NOTES ON OPERATION

SERVICE PIPES—All service pipes are cement-lined 1-in. and 1⅛-in. wrought-iron pipe. The lining is done by the municipal labor crews in the winter when other work is slack. The cost of the pipe with cement lining per lin.ft. is 4.73c. for 1-in. and 7.84c. for 1¼-in. pipe. The pipe is sold to the property owners at 10% increase over these prices.

All service connections are made by lead goose-neck connections with the mains, to take the water-hammer and shock. There are now no curb cocks inserted for cutting off house services. Instead, a regulation corporation cock is inserted alongside the main, in the street. The cock is inclosed in a cast-iron box made in two sec-

FIG. 7. STABLE BASEMENT STOREROOM, WORCESTER WATER-WORKS DEPARTMENT

FIG. 8. STABLE, WORCESTER WATER WORKS DEPARTMENT; EMERGENCY WAGON

tions (Fig. 9), one tapered, straddling the service pipe and resting against the main (A), and the other (B) cylindrical with a flanged circular top, which lies flush with the street surface. The tapered lower part admits of adjustment to the depth of main below street surface. It is stated that little or no trouble is experienced with this type of service cut off.

FIG. 9. SERVICE CONNECTION BOX

The Department owns two or three large pipe-tapping machines and is in every way equipped to do all the construction and repair work often done in other cities by contract.

**Mine Cave-ins** are so general, almost continual, and the resulting casualties so high, that the United States Bureau of Mines has just issued a circular discussing safety measures applicable to the circumstances. There were employed in and about metal mines of the United States in 1912, 169,199 men, of whom 110,056 worked underground, and 59,143, on the surface. There were 661 fatal accidents—522 underground and 139 on the surface; of these, 212 were caused by falls of rock or ore, representing 32.1% of the total number of men killed on the surface and underground, and 40.6% of the number killed underground. Copper mines showed the largest percentage of men killed from this cause, with iron mines second. Lead and zinc mines showed about the same percentage of fatalities as gold and the miscellaneous metal mines, and were third in order. This indicates that the greatest number of accidents from falls of rock or ore occur in ore bodies of great width.

As in the case wherever men are employed, the personal equation can prevent more accidents than a superabundance of mechanical safety devices. A knowledge of the nature of the ground and the proper method of timbering is essential to efficient working. That rock or ore falls because of lack of support is axiomatic, and the circular claims that the usual tendency whether drifting or stoping is to use too little timber, or to wait too long before placing the timber. All loose rock should be removed from the face, back, and sides as driving progresses, and should be done immediately on returning to the place after blasting. A common cause of falls is failure to use enough blocking about the timber. Where the ground has a tendency to fall or slough off, there should be no space left over the timber sets or lagging. All loose rock should be pulled down, and the spaces filled in solidly with rock or tightly blocked with pieces of timber. The dropping of pieces no larger than a baseball has killed men.

No infallible rules for detecting dangerous ground can be laid down, on account of varying ground conditions in different mines, and even within the same mine. The usual method of spotting a dangerous piece of rock overhead is to tap the suspected place (gently at first) with a pick handle. If the sound given out indicates that it is loose it is called a "drummy," and although it may stand for years, certainty demands that it be pulled down at once. A study of the accidents occurring in a certain large mine showed that most of the falls occurred in what was thought to be safe ground. The obvious reason was that in treacherous ground greater care was exercised. The company owning this mine arranged for closer inspection of workings, and thereafter used twice as much timbering. It is said that after a six-months' trial the reduction in the number of accidents from falls amounted to 50%.

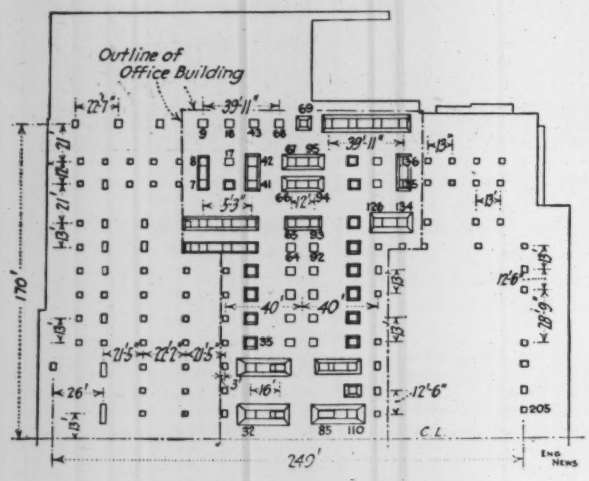
# A Large Reinforced-Concrete Mat Foundation for a Seventeen-Story Office-Building

The two accompanying drawings represent the foundation slab or mat of reinforced concrete on which rests the 17-story office-building portion of the new passenger terminal of the Michigan Central Ry. at Detroit. This unusual type of foundation was employed because the character of the subsoil did not promise any better results from deep foundations, piers, piles, or the like, than could be secured with shallow footings, and at the same time a base slab was desirable to forestall unequal settlement. The advantage of economy lay with the mat foundation, by a large margin.

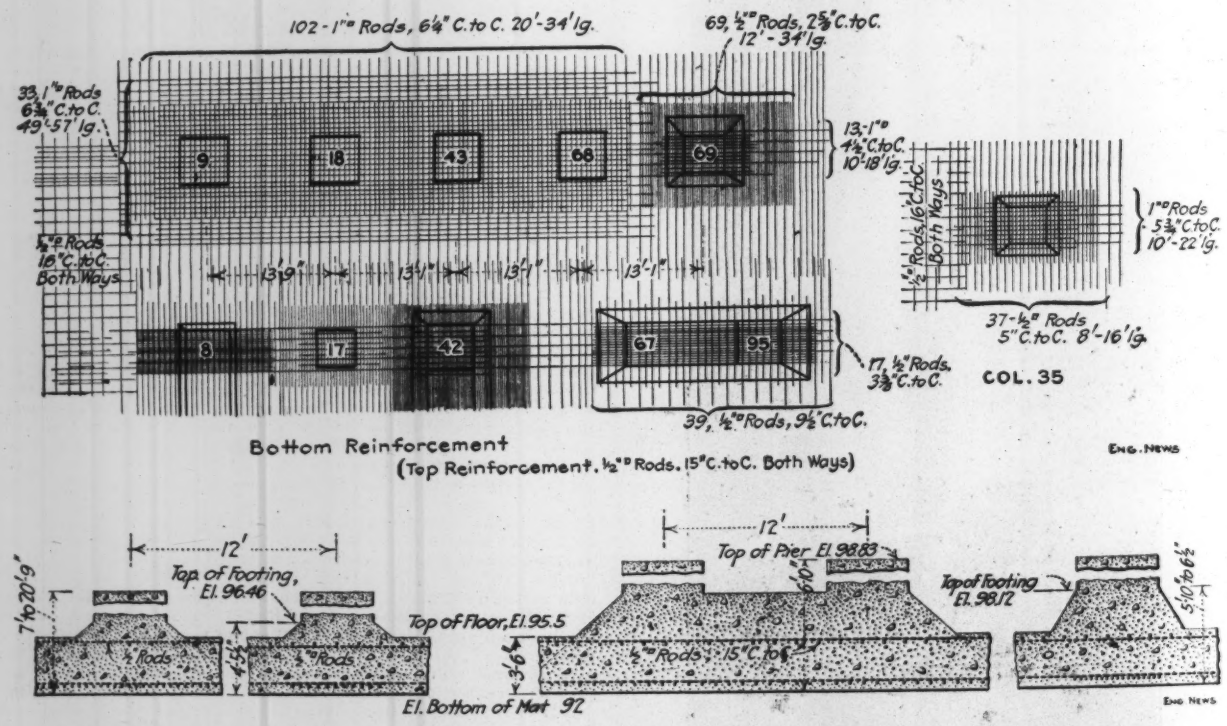
Elaborate piledriving and loading tests and soil-loading tests were made on the site of the proposed station before the foundation design was settled on. The site is a mile or more from the central business district of Detroit, and no high or heavy buildings exist near it, so that reliable precedent was lacking. The deep bed of clay underlying Detroit, averaging over 100 ft. to rock, varies in physical character so much that the downtown practice in heavy foundations could not be taken as applicable to the case.

The conclusion from the soil-loading tests was that at cellar level a loading of 2 tons per sq.ft. of loaded area could be carried without appreciable settlement. The pile tests, on the other hand, did not indicate that any advantage in stability or economy would result from the use of piles; at the same time there remained some doubtful features in the behavior of the piles under long-continued test loading, which suggested that working on piles should be kept very low, possibly below 15 tons per pile. The engineers of the railway company concluded in favor of a mat footing, and their opinion was confirmed in the report of Olaf Hoff, who was called in consultation.

The mat footing as designed for the 17-story building is a 42-in. slab of concrete reinforced at top and bottom by continuous layers of rods. Under the single-story waiting-room and concourse portions, north and south of the office-building, the slab is 30 in. thick. At the edges the slab is extended somewhat beyond the footing-width of the outer columns, to prevent any possible hogging action, i.e., settlement at the edges of the mat from lateral flow of the clay subsoil. The bottom of the




GENERAL PLAN, WEST HALF OF MAT


102 - 1" Rods, 6¼" C. to C. 20'-34' lg.
69, ½" Rods, 2⅝" C. to C. 12'-34' lg.
33, 1" Rods 6¼" C. to C. 49'-57' lg.
13, 1" 4½" C. to C. 10'-18' lg.
½" Rods, 16" C. to C. Both Ways
1" Rods 5¾" C. to C. 10'-22' lg.
½" Rods 18" C. to C. Both Ways
13'-9"
13'-1"
37, ½" Rods 5" C. to C. 8'-16' lg.
17, ½" Rods, 3⅜" C. to C.
COL. 35
39, ½" Rods, 9½" C. to C.
Bottom Reinforcement
(Top Reinforcement, ½" Rods, 15" C. to C. Both Ways)
ENG. NEWS
12'
Top of Footing, El. 96.46
7' to 20' 9"
Top of Floor, El. 95.5
Top of Pier El. 98.83
Top of Footing El. 98.12
5' 10" to 6' 4"
¾" Rods
1" Rods
½" Rods, 15" C. to C.
El. Bottom of Mat 92
ENG. NEWS

REINFORCED-CONCRETE MAT FOUNDATION UNDER MICHIGAN CENTRAL TERMINAL AND OFFICE-BUILDING; DETROIT, MICHIGAN

mat (Elev. 92) is 2 ft. below the mean level of the Detroit River (Elev. 94), and 27 ft. below ground level in front of the building.

The loads of the columns bear on the mat through spread reinforced-concrete footings proportioned as if for direct soil support, but at the higher loading of 4 tons per sq.ft. This is intended to reduce the bending moments in the mat. The reinforcement of the mat is proportioned empirically.

The mat was built by concreting direct on the floor of the cellar excavation. It was necessary to place the concrete in sections (defined by vertical bulkheads), but the continuity of the reinforcement makes the mat in effect a monolith.

The mat was built in June, 1912. Up to the present, no settlements of any kind have been detected by careful leveling.

The design of the foundation is due to George H. Webb, Chief Engineer of the Michigan Central Ry. The company's architect, Edward W. Smith, and W. B. Goddard, Jr., Structural Engineer, collaborated in the work, and carried out the detail designing. Geo. A. Fuller Co., contractors for the entire station building, constructed the foundation.

## Track Elevation in Chicago

The elimination of grade crossings of streets and railways in Chicago represents one of the most extensive and costly engineering works in the country. The work has been in progress for some 22 yr., and the report of the city's Commissioner of Track Elevation in 1911 showed that the work then done amounted to 140 miles of road and 843 miles of track, at a cost of $66,256,000. A future total of 192 miles of road and 1265 miles of track was then estimated.

Figures compiled recently by R. H. P. Ford, Engineer of Track Elevation of the Chicago, Rock Island & Pacific R. R., show that at the present time about 1000 miles of track have been elevated, and 1285 subways built, at a cost of over $75,000,000, while when completed, this work will comprise some 2185 miles of track and 2600 subways, with a total cost of $175,000,000. Of this enormous cost, about 98% is paid by the railways, 1.7% by the city and only 0.3% by the street railways and other public-service corporations. The city's share is in assuming all costs of damages to adjacent property due to the track elevation, and the corporations bear the expenses of the necessary changes to their property in the streets and alleys.

In other cities there are more or less costly sections of track elevation (or sometimes track depression) to eliminate grade crossings at certain points, but in Chicago the work comprises long continuous stretches of line, and the project as a whole covers practically all railway lines within the city limits.

The flat country in which Chicago is located led naturally to the early railways approaching and entering the city on the ground level, and they were extended gradually through the city to terminal points, being built either in the streets or on purchased right-of-way. At one time there was a policy of elevating important streets and carrying them across long groups of tracks by viaducts, but this was abandoned some years ago, as the long approach grades were unfavorable to street traffic, while the multiplication of elevated approaches (both on the viaduct streets and on intersecting streets) would cause serious depreciation of value of property. Some of the viaducts have been replaced by subways, and while a number still remain, no new ones have been established for a long time, the fixed policy being the ultimate elevation of all the railway lines.

The Chicago track-elevation movement dates from 1892 when the Illinois Central R.R. secured an ordinance for the elevation of its tracks between 51 St. and 67 St., in order to be able to handle the heavy local traffic during the Columbian Exposition. The city created its track elevation department in 1897, and this was conducted until 1907 by the late John O'Neill, who realized that this was a matter of a definite and comprehensive policy of track elevation for the entire city.

The typical track-elevation work consists of a solid fill or embankment contained between concrete retaining-walls on each side and the concrete abutments of bridges over the streets. There is practically no viaduct work utilizing the space beneath the tracks. It is of a very comprehensive character, including main lines with from four to ten tracks, and in relation to these there are stations, terminals, yards and innumerable sidings and industry tracks. Further, the work has to be done largely in busy districts, and in all cases provision has to be made for carrying on the railway, street railway and street traffic. This involves special difficulties in the planning and execution of the work. At certain points it is complicated by railway-grade crossings. In some of these cases, the railway grades have been separated by means of a double-deck construction, one railway viaduct crossing above the other. In other cases, however, the conditions have not permitted such an arrangement, and it has been necessary to retain the railway grade crossing, but removing it from the street level.

For the numerous bridges across the streets, the designs vary on different roads. In some cases there are steel through bridges, with girders between the tracks, but this prevents any shifting of tracks or the placing of switches to accommodate future conditions, and will be a source of trouble when electrification of the terminal lines is commenced. In other cases, deck-girders or self-supporting through-floor- steel spans have been used, which present no obstructions above the road bed.

Of late years the all-concrete subway bridge has come into use on several lines, the floor consisting of massive concrete slabs which are set in place on the concrete abutments and intermediate piers or bents by means of powerful wrecking cranes or derrick cars. These also provide an unobstructed floor. As different railways sometimes occupy parallel and adjacent right-of-way, many subways present the curious feature (and unfavorable appearance) of two distinct types of construction.

The track elevation in progress at different points of the Chicago railway system presents interesting examples of different designs and methods of execution for work of the same general class. The work must be done on a restricted right-of-way, with a frequent service of trains to be provided for. On account of the density of street traffic, the city will not permit the closing of more than a few consecutive streets at one time, so that a stretch of track-elevation work must be divided into sections, in each of which the operations are separate and distinct. This

complicates the work and the handling of trains, lengthens the time occupied by the work, and adds materially to the cost.

As far as the results are concerned, the railways benefit by greater facility of traffic, and the reduction of damage claims due to accidents at street crossings. The public benefits by the greater facility and safety of street traffic, and the traveling public shares the benefit gained by the railways. The city gains in the general improvement of its traffic conditions and in the greater safety of its population. In this respect, it is of interest to note that grade-crossing accidents in Chicago declined steadily from 69 deaths and 173 total personal accidents per million population in 1899, to 6 fatal and 39 total per million in 1911.

While it is true that the work of track elevation has to some extent been forced upon the railways by the city, much credit is due to the railways for their foresight in recognizing the necessity of the work and in cooperating liberally with the city. And it must be remembered also that practically the whole of the expense of this very costly work is borne by the railways. It is specially worthy of note that in the general policy of track elevation in Chicago and in the planning and execution of the various sections of work, there has been on the whole, the very desirable feature of harmony and coöperation between the railways and the municipal authorities.

# Acceptance Test of a High-Duty Triple-Expansion Pumping Engine at Bissell's Point Station, St. Louis Water Works

By Geo. M. Peek*

In 1912, specifications were drawn for two new pumping units to be installed in Engine House No. 2 at Bissell's Point, St. Louis. These two pumps were to take the place of one old beam-engine bucket-and-plunger machine which was installed in 1893. This old engine was built by the Southwark Foundry & Machine Co., of Philadelphia, at a cost of $110,500. It had a rated capacity of 18,000,000 gal. per 24 hr. against 85 lb. water pressure when supplied with steam at 35 lb. pressure. The tests on this engine showed it to develop a duty of 64,860,000 ft.-lb. of work per 1000 lb. of steam. The original boilers for supplying steam for this engine were an internally fired marine type. In 1908, these were replaced by four water-tube boilers fitted with inclined-grate stokers. The boilers carried a steam pressure of 75 lb., which was reduced, in a large header, to 35 to 40 lb.

In April, 1912, bids were opened and the contract for the two new 20,000,000-gal. pumping engines, to be completed and erected on foundations prepared by the Water Department, was awarded to the Holly Manufacturing Co., of Buffalo, for $193,697. The specifications called for the completion of one unit in 10 months and the other in 12, but the company was granted an extension of time.

The contract called for a duty of 195,000,000 ft.-lb. of work per 1000 lb. of steam (160 lb. pressure and 100° superheat) when pumping against a pressure of 25 lb. in a discharge pipe whose elevation was 105.25 [illegible] with the elevation of water level in the wet well at [illegible]. The engine was required to deliver all of the condensed back to the boilers. The contract called for a bonus of $1000 for each million foot-pounds of work done by the engine in excess of 195 million and a forfeiture of a like amount for each million the duty fell short of the guarantee. One unit was put in service in September, 1913, and was tested Apr. 23 and 24, 1914.

The design shows a vertical flywheel type with single-acting outside-packed plungers, each located under one

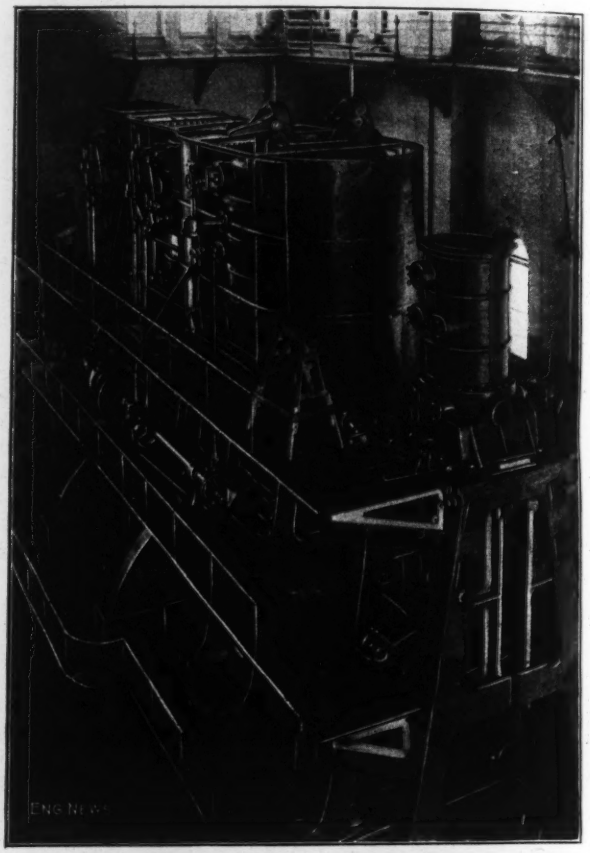


Fig. 1. The 20,000,000-Gal. Pumping Engine at the Bissell's Point Station, Erection Nearly Completed

of the cylinders. Each cylinder has a single piston rod and four distance rods connecting the plunger with the crosshead. The pump ends are arranged for direct flow and have removable steel valve decks. This arrangement is shown in Fig. 2.

The valve gear is worked from a lay-shaft, which in turn, is driven from the main shaft through bevel gears. All valves are located in the heads and, except the low-pressure exhausts, are of the multi-ported Corliss type. The low-pressure exhaust valves are poppets. All cylinders are jacketed and arranged so that the steam passes from the jacket of the high-pressure cylinder to that on the intermediate, then to the one on the low-pressure.

The cylinders are supported on A-frames, which extend

*Mechanical Engineer-in-Charge, Construction Department, St. Louis Water Works, St. Louis, Mo.

FIG. 2. VALVE DECK OF NEW BISSELL'S POINT ENGINE

to bedplates resting on top of the air chambers. The bedplates are arranged so that they may be supported on jacking columns in order that any air chamber may be removed without disturbing any of the superstructure of the engine. The plungers are semichilled and ground. Pump chambers are of cast steel.

The pistons are of cast iron, in one piece, fitted with cast-iron rings, and are finished and polished on both sides. The cylinder heads are polished on the inside. The cylinders are covered with 85% magnesia insulation. The valve cages are of semisteel and the holding down bolts

TABLE 1. DETAILS OF 20,000,000-GAL. HOLLEY PUMPING ENGINE; ST. LOUIS WATER-WORKS

1. Diameter of Steam Cylinders; 34, 64, 98 in.
2. Character of Metal; cast iron.
3. Thickness of inside shell; 1½, 1¾, 1⅞ in.
4. Width of Jacket Space; 1, 1, 1⅛ in.
5. Thickness of Outside Shell; 1⅝, 1⅞, 2 in.
6. Volume of Receivers; First, 206 cu.ft., Second, 294 cu.ft.
7. Thickness of Piston Head; 12 in. throughout.
8. Piston Packing Rings; Cast Iron.
9. Number of Piston Rods; One to each Cylinder.
10. Diameter of Piston Rods; 8 in.
11. Stroke of Piston; 66 in.
12. Revolutions per Minute; 20.
13. Diameter of Steam Valve; 6, 9, 10, 12 in. Corliss, 21 in. Poppet.
14. Location of Valves, All in Heads.
15. Type of Valve Gear. Corliss with poppet exhaust on low pressure.
16. Size of Main Connecting Rod; 8 and 9¾ in. diameter.
17. Length of Main Shaft; 12 ft. 7½ in.
18. Diameter of Main Shaft; 23⅞ in.
19. Diameter of Main Journal; 20 in.
20. Length of Main Journal; 32 in.
21. Metal in Main Shaft; Fluid compressed steel.
22. Size of Cranks; Hub 33 in.; Web 30 in.
23. Size of Crank Pin Journal; 12½x11 in.
24. Diameter of Flywheel; 20 ft.
25. Weight of Rim of Flywheel; 30 tons.
26. Diameter of pump barrel Force Chamber, 5 ft. 4 in. Suction Chamber, 5 ft. 4 in. Suction Air Chamber, 4 ft. 6 in. Discharge Chamber, 4 ft. 5 in. Plunger Chamber, 5 ft. 5¾ in.
27. Metal in Pump Barrel; Cast Steel.
28. Diameter of Cage Plates; 5 ft. 5¼ in.
29. No. Valves each Suction Cage Plate; 247.
30. No. Valves each Discharge Cage Plate; 247.
31. Total number Valves each Pump; 1482.
32. Total Area of Valves each Suction Cage Plate; 1368 sq.in.
33. Total Area of Valves each Discharge Cage Plate; 1368 sq.in.
34. Diameter Valves; 3¾ in.
35. Proportion Valve Area to Plunger Area; 164%.
36. Material in Valves, Seats, Stems and Springs; Rubber, Gun Metal, Bronze, Brass.
37. Lift of Valves; ⅝ in.
38. Diameter of Plungers; 32⅝ in.
39. Speed of Plunger; 220 ft. per min.
40. Total Displacement per Revolution; 716.5 gal.
41. Number of plunger or distance rods; Four to each plunger.
42. Diameter of plunger rods; 5 in.
43. Diameter of discharge pipe; 36 in.
44. Diameter of suction pipe; 42 in.
45. Cooling surface of condenser; 1800 sq.ft.
46. Number of tubes in the condenser; 701.
47. Size of tubes; 1 in. o.d.
48. Metal in tubes; Brass.
49. Size of air pump; 24x66 in.
50. Size of boiler feed pump; 3¼ x66 in.
51. Size of air compressor; 3x66 in.
52. Total estimated weight; 875 tons.

are of manganese bronze. The crossheads are of cast steel and are fitted with solid bronze shoes.

The condenser is a water-works surface type with steam passing through the tubes. It is located in the suction pipe and all the water pumped passes through it. This arrangement might be criticized since it reduces the temperature of the condensate to very nearly that of the water pumped and gives cool boiler feed. It is proposed to install an exhaust feed-water heater on this engine to increase the B.t.u. duty. A method of bypassing only a part of the water pumped through the condenser is followed with some of the pumps of the Department but after considering all of the working conditions it was decided that the scheme adopted was the best.

Among the miscellaneous items of interest are the following: governor controlling the cutoff of the high-pressure cylinder with hand-controlled cutoff on the intermediate and low-pressure cylinders; a sight-feed force lubricator from which feed connections are made to all rotary valve stems, the throttle and intermediate-cylinder side pipes; a central oiling system with filters and oil tanks; a two-stage air compressor for supplying air to the air chambers. Further details of the pumping engine are summarized in Table I, which shows the data required of the contractor with his bid.

Table II gives the data which was obtained from the test log sheets. The figures given are averages for 24 hr.

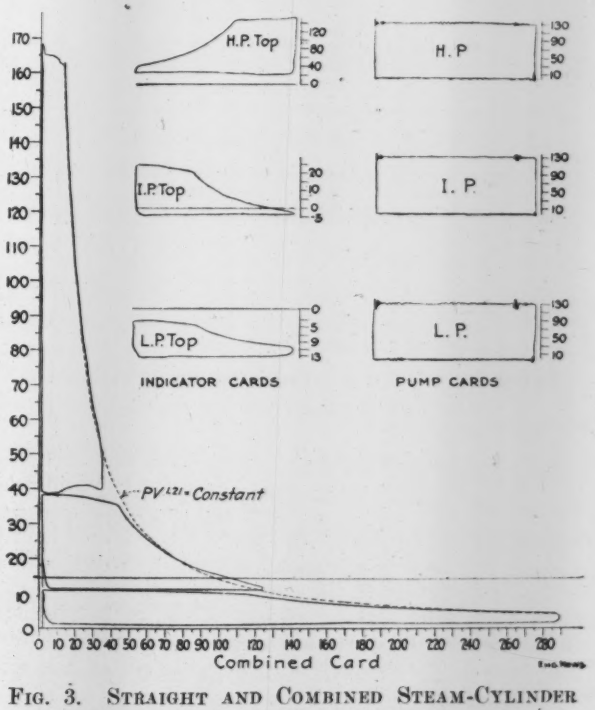



FIG. 3. STRAIGHT AND COMBINED STEAM-CYLINDER CARDS AND PUMP DIAGRAMS; NEW BISSELL'S POINT ENGINE

Table III gives the results as calculated from the data given in Table II. The discharge pressure was measured by means of a mercury column. The specific gravity of the mercury when at 58.48° and compared with the water pumped, at the same temperature, was found to be 13.58. The weight of a cubic foot of water at this temperature was taken to be 62.38 lb.

TABLE II. TEST-LOG DATA; ST. LOUIS 20,000,000-GAL. HOLLEY PUMPING ENGINE

1. Steam Pressure; 159.43 lb. per sq.in.
2. Barometer; 29.795 in.
3. Superheat (as read by thermometer); 101.58°.
4. Vacuum; 28 in.
5. Temperature of Exhaust; 96.88°.
6. Reading of Pressure Mercury Column; 301.55 ft.
7. Elevation Pump Discharge; 92.
8. Average Temperature of Mercury Column; 76.13°.
9. Elevation Water in Wet Well; 95.31.
10. Diameter H. P. Plunger; 32.62 in.
11. Diameter I. P. Plunger; 32.616 in.
12. Diameter L. P. Plunger, 32.615 in.
13. Stroke of H. P. Plunger while running; 65.875 in.
14. Stroke of I. P. Plunger while running; 65.828 in.
15. Stroke of L. P. Plunger while running; 65.906 in.
16. Water Pumped in 24 Hours (actual plunger displacement); 20,576,500 gal.
17. Water Pumped in 24 Hours (Venturi meter readings); 20,610,000 gal.
18. Weight of Condensate; 230,145 lb.
19. Weight of First Receiver Drain; 1883 lb.
20. Weight of Second Receiver Drain; 8299 lb.
21. Weight of Jacket Drain; 11,763 lb.
22. Total weight of steam; 252,090 lb.
23. Weight of steam per hour; 10,503.7 lb.
24. Temperature of water pumped; 58.45°.
25. Temperature of Condensate; 61.79°.
26. Temperature of First Receiver Drains; 263.104°.
27. Temperature of Second Receiver Drains; 197.705°.
28. Temperature of Jacket Drain; 164.297°.
29. Plunger leakage per hour; 333 lb. (Specification allowed 100 gal.).

Fig. 3 shows a set of indicator cards. This set was taken at a time when all of the conditions were as near as possible to those of the specifications. All indicator cards both steam and pump ends, were taken every hour and were taken simultaneously by electric control. Fig. 3 also shows a combined card made from the set of ordinary cards after they were corrected for the spring calibration. The curve $pv^{1.21} = constant$ is the nearest $pv^n = constant$ curve to that shown by the indicator cards*

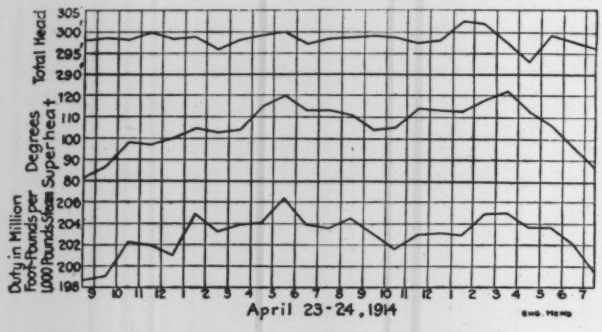



FIG. 4. HEAD, DUTY AND SUPERHEAT CHARTS FOR TRIAL RUN OF BISSELL'S POINT ENGINE

Fig. 3 shows also the set of pump cards corresponding in time to the other cards. Fig. 4 is a chart showing the relation between duty, superheat and total head pumped against for the test run. The duties were figured hourly and do not take into account the small correction due to the temperature of the mercury column. The maximum duty, after making all corrections, of 202,105,616 ft.-lb. per 1000 lb. of steam at 160 lb. pressure and 100° superheat is the highest of which the writer has any knowledge.

The test was conducted for the City of St. Louis by L. A. Day, Chief Mechanical Engineer of the Water Department and the writer. The Holly Co., represented by D. A. Decrow, Chief Engineer, and H. E. Gibbs, who prepared the pump for testing. There were 25 observers taking readings during the test.

*The exponent of "v" may be determined in the following manner: The equation "pvn = constant," may be written in the form, "log p + n.log v = log c," and by plotting the logs of the quantities instead of the quantities themselves the equation then takes the form "y = nx + k," which is an equation to a straight line with "n" as the tangent which the line makes with the "x" axis and "k" would be the intercept on the "y" axis. By taking a number of points on the expansion line of the combined card, plotting their logs as indicated above and then drawing a straight line through or nearest the majority of these points the constant as well as the exponent may be found for that curve which will come nearest to the expansion line as shown by the indicator cards.

TABLE III. AVERAGE TEST RESULTS; ST. LOUIS 20,000,000-GAL. HOLLEY PUMPING ENGINE

1. Absolute steam pressure; 174.03 lb. per sq.in.
2. Superheat (corrected emergent stem thermometer); 105.23°.
3. Average value of superheat in duty; 10° equals 1,000,000 ft.-lb.
4. Pressure by mercury column (corrected for temperature); 301.013 ft.
5. Total head pumped against (95.31 — 92 = 3.31; 301.013 — 3.31 = 297.703); 297.703.
6. Gallons per revolution; 714.437.
7. Weight water pumped per revolution; 5957.7 lb.
8. Average revolutions per hour; 1200.
9. Duty, foot-pounds per 1000 lb. steam without correction for excess in superheat.
$$\frac{1200 \times 5957.7 \times 297.703}{10.5037} = 202,628,616.$$
10. Deduct for 5.23° of superheat, net duty; 202,105,616 ft.-lb. per 1000 lb.
11. Heat per pound superheated steam; 1256 B.t.u.
12. Total heat delivered to engine; 316,625,040 B.t.u.
13. Heat per pound condensate; 29.87 B.t.u.
14. Total heat in Condensate; (13) × (18II) 6,874,431 B.t.u.
15. Heat in one pound of First Receiver Drains; 231.8 B.t.u.
16. Total heat in First Receiver Drains; (15) × (19II) 436,479 B.t.u.
17. Heat per pound Second Receiver Drains; 165.63 B.t.u.
18. Total heat Second Receiver Drains (17) × (20II); 1,374,563 B.t.u.
19. Heat per pound jacket drains; 132.16 B.t.u.
20. Total heat Jacket drains (19) × (21II); 1,554,598 B.t.u.
21. Total heat rejected; 10,240,071 B.t.u.
22. Heat consumed by engine; 306,384,969.
23. Total foot-pounds work done in 24 hr.; 51,080,404,697.3.
24. Duty foot-pounds of work per million B.t.u. consumed by engine,
$$\frac{24 \times 1200 \times 5957.7 \times 297.703}{306,384,969} ; 166,719,796.$$
25. Water horsepower developed; 1074.91.
26. Steam per water horsepower-hour; 9.77.

**The Remarkable Success of Typhoid Vaccination** in France and the French colonies was brought before the engineers of the Ponts et Chaussées of France by Prof. H. Vincent, of French Academy of Medicine, in a paper published in the Annales des Ponts et Chaussées, May-June, 1914. Prof. Vincent described in detail the nature of the vaccination and its effect on the individual and presented finally a table showing the comparative morbidity and mortality records in a number of small epidemics and particularly among the French army resident in northern Africa. These figures in the original are given for each town and army camp and state the number of non-vaccinated and vaccinated persons, with the number of cases of typhoid and deaths from typhoid in each class.

A compilation of the figures shows that in 525,000 non-vaccinated persons the average typhoid rate was 63 per thousand, whereas in 65,000 persons subjected to the same conditions but vaccinated against typhoid, the morbidity rate was practically nothing, there being reported only two cases. In the non-vaccinated class the typhoid rate ran as high as 225 per thousand in the epidemic at Avignon (July, 1912) and 168 per thousand in the army camps in western Monocco in 1912.

**The Fuel-Briquetting Industry** in the United States in 1913 was characterized by a net decrease of two in the number of operating plants and a decrease of 17% in quantity, but an increase of 5.8% in the value of the manufactured product. The United States Geological Survey explains this condition by stating that briquetted fuel in the United States is essentially a domestic fuel, for which there was less demand in 1913, owing to the mildness of the winter. The explanation for the higher values in the face of decreased demand appears to lie in the general enhancement of values of all industrial products in that year. In the production of briquets, seven plants used anthracite culm or fines; one used semi-anthracite; one semi-anthracite and bituminous slack, mixed in proportions of 3 to 1; one used anthracite culm and bituminous slack, principally the former; five used bituminous or semi-bituminous slack; and two used carbon residue from gas works making gas from petroleum; eight plants used coal-tar pitch for binder; one asphaltic pitch; one water-gas pitch, and five mixed binders of composition not divulged.

The total production amounted to 181,859 short tons, valued at $1,007,327, compared with 220,064 tons valued at $952,261 in 1912. The production for the four years preceding 1912 was as follows: 1907, 66,524 tons; 1908, 90,358 tons; 1909, 139,651; 1911, 218,443.

# Editorials

Columbus' noted egg-balancing feat finds a sort of parallel in a modern pile test, where the engineer sets a 40- or 60-ton load on the top of a slender pile of doubtful verticality and straightness, and expects it to stay put while he measures the settlement of the pile. A correspondent recommends guying such loads; yet the Pittsbugh tests and the Panama-Pacific Exposition tests (in our issue of July 30, 1914) were successful without guying.

The prominent fact of the matter is that pile testing has hitherto been thought very unimportant, so that descriptions or discussions of proper methods of pile testing are scarce as snowflakes in June. The same is true of soil-loading tests. Both kinds of test give highly valuable information, and (in our view) are destined to find wide use in the future. At the same time, both tests may prove to be either inexpensive or very costly, depending on the way the test is arranged. And, what is even more important, the information furnished by the test may be instructive or seriously misleading, again depending on the test method. There is room for fuller study of the subject.

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Detroit has foundation problems quite peculiar to itself. Many different solutions are to be found among the structures erected in that city, each one being found of interest. Among them not the least is the remarkable foundation of the new Michigan Central terminal and office building. We believe it is little exaggeration to class this foundation among the notable examples of building-foundation work of the last half dozen years.

No other 18-story steel-frame building of modern times rests by means of a very thin shell of reinforced-concrete directly on deep clay soil of uncertain and variable character.

A discussion of the problem presented in the case, and of the solution adopted, is of course outside of the editor's sphere, and may be safely left to the members of the profession competent for it. But to supplement our descriptive article, we should note that in the course of the design, one expedient was recommended which later was not embodied in the structure, and commentators may well consider its bearing on the case. This was a line of sheeting, which was to be driven around the edge of the reinforced-concrete mat, some 15 or 20 ft. into the soil below, to act as a confining curb, a protection against possible localized outward flow of the clay under the foundation pressure. This expedient was recommended by a highly conservative and competent engineer, but was finally overruled. As built, the foundation subsoil has no restraint to outward flow, and no such flow is expected.

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It is alarming to learn that under traffic conditions which exist in many parts of the country standard practice in designing highway bridges is inadequate (this means *unsafe*) for short spans—spans up to 50 or 60 ft. Bridges have been designed to carry road rollers (and only one roller at a time), while the actual traffic requires them to carry much heavier motor trucks, and two of these will often pass each other on a bridge. Further, when a truck going at a speed of 6 to 10 miles an hour bumps along over a rough bridge-floor, there is a respectable amount of impact, although talk about highway-bridge impact has hitherto been regarded as highly academic, not to say hairsplitting.

It may be thought that the statements and conclusions given by Manville and Gastmeyer on another page of this issue are overdrawn and needlessly disquieting. But the engineers of Cuyahoga County, Ohio, recently took action along exactly the same line of thought; they carefully reviewed all bridges under their charge to learn how they are stressed under motor loads, so that those bridges which cannot safely carry modern freight-truck traffic may be known, and warning notices posted to limit their loading.

The fact is that commercial motor trucks have grown amazingly in number, and at the same time heavier and heavier capacities and axle-concentrations have been employed. This has progressed to a point where the safety of road bridges is menaced. The truck builders are not to be blamed, for they merely followed the demands put forward by truck users; they went about their own business in the tacit belief that bridges as well as roads could carry anything that might cross them.

Bridge engineers are notoriously conservative. They design only for existing loads, rarely looking toward a speculative morrow. The Pennsylvania Highway Commission some time ago established a 24-ton truck as standard for designing bridges on main roads near cities; in New Jersey a 20-ton truck is assumed; and possibly some other authorities are equally progressive. But in the main the growth of street and road loadings has left highway bridge practice in the rear. It is necessary to revise the current standards.

The immediate need, however, is to study existing road bridges, decide what loads may be allowed to pass over them, and post notices stating the limit of allowable load. This duty rests in part on the states, but in larger part on the counties, who are the real road authorities. Public safety requires them to act.

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## Preserving Concrete Linings On Fresh Canal Banks

The difficulties in placing concrete on newly made slopes in such a way that it will hold its form and alignment, are so frequently noted that instances of conspicuous success are of unusual interest. Therefore attention is directed to the description, elsewhere in this issue, of the work on lined canals for the Seros power project near Barcelona, Spain. Here are to be seen some 17 miles of relatively deep canals connecting the diversion works, regulating reservoirs and penstocks. Attempts

to spread an impervious lining on the slope of 1½ on 1 were futile and forms had to be used. Only three-fifths of the height of bank was lined at first, the work being completed after water had been in and the initial settlement obtained. In testing out this construction, any serious displacement of the lining was anticipated by watching for the development of cracks between concrete and earth at the top of the bank and forcing a clay puddle into the dangerous spots to maintain continuous support. Only something like 3½% of the canal banks required any treatment.

It is also interesting to note that similar means was successful in sealing incipient settlement cracks of the seven earth dams on this project (to be described in a subsequent issue), so that the combined leakage, including that through the rock strata of the hillsides was under 3 sec.-ft., or 7/100% of the normal flow from storage.

## The Next Convention of the New England Water Works Association

The New England Water Works Association, which will meet in annual convention at Boston next week, occupies a unique position. By establishing a non-resident membership, publishing an excellent quarterly journal, and later on by holding some of its annual conventions outside of New England, this organization with a local name has achieved high rank among the national technical societies of America.

While being a national society, the New England Water Works Association has served admirably not only the geographical section indicated by its name, but also the more local needs of the Boston metropolitan district. The sectional and local needs have been met by the maintenance of rooms and a library in conjunction with the Boston Society of Civil Engineers and by its monthly lunches, which keep up social relations and afford a never-neglected opportunity for the presentation of papers and for informal discussions of the problems of the water-works superintendent and engineer. The rooms, library and monthly meetings are, of course, open to all non-resident members as can avail themselves of the privilege, and the monthly meetings go far in providing live material for the *Journal*, which through several decades has been a pulsating cord binding all the members together, regardless of geographical location and all other diversified conditions.

For a few years the New England Water Works Association equaled, if it did not exceed, the American Water Works Association in membership, as it had long surpassed it in usefulness to the water-works profession. Recently, the American Association has forged ahead in membership, got out from under various clouds, started a quarterly *Journal*, made possible the formation of sections throughout the country, and established a New York section. The American Association is not yet in position to have permanent headquarters, but there is reason to hope that this may be possible within a few years.

Although we have no reason to think that the officers of the New England Water Works Association are trembling in their shoes lest their organization be forced back into New England territory and there cramped and confined by the American Association, we have no doubt but that the New England officials are awake to the friendly rivalry that exists. One of the claims made in behalf of the American Association is that it surpasses the New England Association in usefulness to superintendents. Unless we are greatly mistaken, a careful analysis would show that most of the papers and notable committee work in each association have been contributed by engineers rather by superintendents.

However all this may have been in the past, the program of the New England Water Works Association for its convention to be held at Boston, on Sept. 9 to 11, devotes several sessions exclusively to superintendents. This is a desirable thing to do. The superintendents make up a high percentage of the membership of all the water-works associations. Water-works are constructed in relatively brief time, but have to be operated 365 days and nights in the year. Strangely enough, relatively few papers dealing with strictly operating problems are presented, and there are practically no books on water-works operation in existence. It is sincerely to be hoped that the superintendents' sessions at the Boston convention next week will be fully attended and the papers extensively discussed.

## How May I Become an Engineer?

Although not so specifically put, the above title is the question a correspondent is asking when he writes:

> Some time ago there appeared in your magazine an editorial urging young men who have an engineering education and who are willing to "rough it," to go out West and, starting out as county surveyors, or in any other capacity in the employ of some municipality, endeavor to build up a general engineering practice. Will you kindly suggest a way in which a young engineer hesitating to spend a good deal of his ready money in order to get to a part of the country, which is to him as yet shrouded in a haze of mystery, and there wait until he is lucky enough "to strike a job," may get in communication with someone who could give him more definite information before he ventures out of his home city? I believe that a suggestion of this kind would be welcomed by a good many young engineers.

First let us correct an erroneous conclusion our young friend has evidently drawn from our editorial, "A Neglected Opportunity of the Engineering Graduate" (ENGINEERING NEWS, Dec. 11, 1913, p. 1196), in which we pointed out, from very good evidence on another page of the same issue, that many county surveyors and county engineers in some of the Middle Western States are incompetent and ignorant, and that young engineering graduates were neglecting their opportunities in not getting in line for these offices.

We did not then, and, so far as we know, never have urged young men to go West and ask for positions as county surveyors and engineers. County engineer jobs are not to be had that way; unfortunately, as we have said before, many are too much mixed with politics. Neither have we now any advice or suggestions to offer our young friend as to how to secure these positions, since there are other things he will have to learn first. But we will undertake to offer for his perusal, and by chance the perusal of the "many other young engineers" referred to, a few truths that it is time he and they knew.

First, this is a tough year for the new engineering graduate. Jobs in engineering work are few and hard to

get. Second, there are a great many engineering college graduates; an estimate of 5000 per annum is conservative, from what might be termed first-class technical schools and universities. More than that, according to the United States Immigration statistics for the fiscal year ending June 30, 1912, some 1500 admitted aliens were professional engineers, who are for the most part in this country now, although present European conditions will restrict such immigration for a few years to come. Hence from the nature of things, competition for work in the lower ranks of engineering is keen.

Another point to be remembered is that graduation from a technical school doesn't make an engineer: If the institution from which our correspondent has just been graduated has granted him the degree of Civil Engineer, why so much the worse for our young friend if it has aroused in him visions of his glad welcome into the ranks of real engineers. All other things being equal, his chance of becoming a civil engineer is better than that of a fellow who has not had the advantages of a technical education; but that is all that can be said.

He would like to know how to begin as an engineer; he needs to know the prime requisites of an engineer. First and foremost, and the one that is most frequently neglected and overlooked, is a natural inclination, or an inherited or otherwise acquired predilection for mathematics and the natural sciences. The natural inclination must be more than a desire for an outdoor life and the pleasure of tramping through green fields and shady woods. Secondly, and hardly less to be considered, are self-confidence and self-reliance. There never was a successful engineer without these, however modest and unassuming in outward demeanor. A third and by no means the least prime requisite is industry—a real love and enthusiasm for engineering work as such, and a genuine joy and innate pride in results accomplished.

As to the first of these requisites, we do not know how our correspondent stands; he alone is judge of that; but we do know that our technical schools and universities are turning out annually many bright young men who have taken engineering courses solely from having been misled by extravagant and utterly untrue pictures of the lives and prosperity of the rank and file of civil engineers. Many an engineering graduate comes to a realization of his special fitness for some other work before he has been out very long. He seldom has cause to regret his technical education, if it were really an education and not the memorizing of a conglomeration of facts and formulas.

On the second essential requisite, we should judge our correspondent needs enlightenment. If a young man is able-bodied and not afraid of manual work, and is free from family responsibilities, he certainly should not be afraid of starving, even if he has not had the advantage of nearly 20 years of schooling, as most technical graduates have.

There is not a contractor, railway or other corporation, or individual, who would not employ an able-bodied American college man in preference to a foreign "roughneck," if the college man were willing to roll up his sleeves and get to work. Such a job isn't inviting, but it offers experience that can be gained in no other way; it offers an opportunity to get into contact with construction work and with engineers, and without these no man ever yet progressed very far as an engineer.

This year, jobs are not coming to the engineering graduate; owing to the tremendous outflux of engineering graduates, it is doubtful if that time ever comes again. In England, young graduates pay a premium for the chance to work at engineering. Some of our graduates might prefer this method, but they are not the stuff of which American engineers have been made. More than one railway officer and chief engineer has started his career as a sectionhand; college men have not infrequently started in this way, and doubtless every one of them who has afterward attained success feels very proud of his early experience, as he has a right to do.

If one lacks self-reliance, there is no better way of curing this failing than to prove to himself that he can earn his bread and butter by the sweat of his brow. This isn't an idle fancy or a theoretical discussion; it is based on personal experience, and the experience of many another man. We sympathize with our young friend, but if a fellow hesitates to leave home and free board for fear of not being able to earn his living, he would better have stayed at home always than have gone to an engineering school.

As to industry, it is hardly worth while to elaborate, since every man ought to know that it is the only key to success in any line of work. Not all men who are industrious are successful, by a long shot. Yet it is safe to say no man was ever very successful as an engineer who wasn't industrious. Of course, one soon learns that opportunity cuts a big figure; or will we say just pure dumb luck? But luck in the game never comes to one who doesn't join in the game. This is just as true in engineering work as in almost any other.

Engineers and contractors, as Col. H. G. Prouty says, are the stuff that soldiers were made of; in the field, they are generally a rough and ready lot, used to forming quick judgments and making quick decisions. "He who hesitates is lost," is just as true of the engineer as of the soldier in the field of battle. No one of these men is going to think the worse of a young man for having served as a laborer or in any capacity that meant real serviceable work. There are no social distinctions in a construction camp, and an extra-bright laborer stands a far better chance of winning the respect, friendship and assistance of his employers, and of the engineers he comes in contact with, than an unknown "tenderfoot" who wants to be guaranteed a good position before leaving home and father's dining table.

We don't say "Go West, young man." If a recent item in a Western contemporary be correct, no less than 2000 applications for positions have been received for work on the proposed Hetch Hetchy Reservoir of the city of San Francisco. Evidently, the West offers no more and no better opportunities than the East, except that in the West there is a more democratic attitude toward work in general.

However, there are opportunities in both the East and West for men who are strong enough in body and purpose to handle a pick and shovel, run a dinky, a steam shovel, a concrete mixer, work with a hammer and saw, and a thousand and one other jobs, which the average engineering graduate turns up his nose at. These jobs are not inviting, truly, but they offer a means of earning a livelihood and they offer one way to enter the ranks of engineers; a way that many a bright, clever and ambitious fellow has made use of before now.

# Letters to the Editor

## Balancing the Load in a Pile Test

Sir—In your issue of Aug. 6, 1914, you describe load tests on concrete piles at North Side Point Bridge approach, Pittsburgh. From the sketch accompanying this article it would appear extremely difficult if not physically impossible to maintain such a large water tank in absolute balance over the pile. Would it not be more satisfactory to make such a test by supporting a tank on a platform on top of the pile and attaching to the sides of the tank horizontal guys, which would not affect the vertical action of the load?

T. L. CONDRON.

Monadnock Block, Chicago, Aug. 20, 1914.

## Use of Current Meters in Large Pipes

Sir—In the June 11, 1914, issue, you published an article by K. A. Heron entitled, "Current Meters for Measuring the Flow in Large Pipes." Reference is made to experiments at the Minnequa steel plant of The Colorado Fuel & Iron Co., where both meters described "have been in use for several years." The statement is made that "the experiments were conducted and the meters designed by A. A. Weiland and the writer under R. M. Hosea, Chief Engineer of The Colorado Fuel & Iron Co."

Your attention is called to the *Journal* of the Western Society of Engineers, Chicago, May 17, 1911, and ENGINEERING NEWS, May 25, 1911, where is a paper, "Measuring the Flow of Water in Large Pipe Lines," in which the result of experiments and the work referred to by Mr. Heron is authoritatively given. The meter illustrated by him in Fig. 1, was designed and constructed by J. S. J. Lallie (deceased), mathematical instrument maker, Denver, Colo., early in 1908, in response to a request for a meter that could be inserted into a pipe line through a 6-in. gate valve, quite a time prior to Mr. Heron's employment by this office. The meter illustrated in Fig. 2 was first constructed in the shops of the Colorado Fuel & Iron Co., Pueblo, Colo., in 1908 and 1909, from plans made in this office, drawn by R. G. Hosea, and embodying his ideas and those of A. A. Weiland, H. A. Deuel and other engineers and employees of the company. This was also prior to Mr. Heron's employment, except as concrete inspector.

This device giving satisfactory results, an improved plan was prepared and submitted to W. & L. E. Gurley with the request for such additions and improvement as their wide experience might suggest. The mechanism for operating the counter was shown in Reuleaux's *The Constructor*, and it and the entire meter were constructed by W. & L. E. Gurley and put into practical form in a creditable manner, as shown in the writer's paper before the Western Society. Mr. Heron worked under direction on the sketches for this improved device in this office in July, 1909, for a time. Before and after this date he was regularly employed as concrete inspector until leaving the service in June, 1910. Mr. Weiland was engaged in water-investigation work with the writer in 1908 and 1909, but left the service of the Colorado Fuel & Iron Co., Feb. 15, 1910, before the improved meter was built or used.

Some work was done with the pitometer on our pipe lines, by Mr. Weiland, and he made the suggestion of inserting an electrical meter in a closed pipe in the same manner as the pitometer (as shown in E. S. Cole's article "The Pitometer & Water Works Losses," in the 1907 *Proceedings* of the American Water Works Association). The putting into practical form was, however, done by Mr. Lallie and others and Mr. Heron had nothing to do with it. He was probably not familiar with the facts when he prepared his article. For the reasons given in ENGINEERING NEWS, May 25, 1911 (and in the present letter), the design was given publicity.

The foregoing gives the bare statement of facts which the writer believes he is in a better position to do than Mr. Heron. In fairness to all concerned, I request publication of this letter.

R. M. HOSEA,
Chief Engineer, The Colorado Fuel & Iron Co.

Pueblo, Colo., July 3, 1914.

[Mr. Heron has offered the following comments:]

Sir—As suggested by Mr. Hosea, I was not aware that a description of the meters had been previously published. The publications mentioned are not available at the moment, but if Mr. Hosea's description was in the same manner as is his letter it is not too late to extend the credit he has given for this work. He has unkindly relegated me to a "thinking part," and then describes Mr. Weiland's leaving the service of the company "before the improved meter was built or used."

I was connected with the Colorado Fuel & Iron Co. for the greater part of four years, and most of this time was spent in the Water Department of the company on various engineering work. From three years' close association with Mr. Weiland, and with an intimate knowledge of the operations of the water department, I have always understood that this electrical meter was developed solely by him, and was made by Mr. Lallie in the manner suggested by Mr. Weiland, who was in charge of water investigations for the company in 1908-09-10. I assisted Mr. Weiland in the rating of this instrument, and in a number of experiments during the summer of 1909.

In the early part of 1910, Mr. Weiland left the service of the company. I had been associated with him for a time, and shortly before he left we started the preparation of plans of what was then the improved meter. The meter, as constructed by W. & L. E. Gurley, was according to a set of plans that were prepared in their entirety by me (under the general direction of Mr. Hosea), applying the more extended experience in this line of Mr. Weiland. As Chief Engineer of the company, Mr. Hosea

was responsible for all the work of the engineering department, and may choose without question whatever credit he desires for his work.

Mr. Hosea seems to think that I am claiming too much credit for the part I took in this work when, as a matter of fact, I was merely describing an interesting method of water measurement in the development of which I had assisted.

K. A. HERON.

Modesto, Calif., July 16, 1914.

## Opportunities for Engineers in the Argentine; A Warning

SIR—After reading the editorial in ENGINEERING NEWS, Aug. 20, p. 407, on the opportunities offered by the present European war to American commerce and engineering in South America, it has seemed advisable that a note of warning in regard to conditions of employment be sounded for some of your readers who may have drawn false conclusions from your remarks.

A young structural draftsman recently informed the writer that he had been devoting special attention to skewed work for the reason that the people of the Latin-American countries are swayed by their artistic natures to such an extent that their architects design very complicated roofs, domes, cupolas, etc., on all their buildings; and, since not many draftsmen are skilled in detailing such work, it follows that there must exist a demand for those with the necessary qualifications.

Granting without question the great amount of queer roofs to be seen in South America, the conclusions drawn are quite wrong. It must be remembered that industrial work in South America and in Europe is regulated by very different customs from our own.

The functions of the American engineering draftsman are carried out by two types of men. The first is merely a mechanical copyist, who makes tracings or show drawings from the sketches of engineers. His pay in the Argentine is about $65 per month, which, considering the high cost of living, is about equivalent to $50 in this country. He works slowly, but with skill, and produces drawings beautifully lettered and elaborately finished, often in colors.

The second type is that of the German "techniker," somewhat similar to the "designing" or "engineer draftsman" of our better railway bridge drafting rooms. He is competent to and does design simple structures and prepares the detailed pencil drawings for the tracers. His pay is about $130, or, say equivalent to $100, and is very seldom increased.

A "techniker" is a graduate of a "technikum" or school offering two-year courses in specialized branches of engineering. Its graduates are often men of much practical experience, who have wished to study some of the theory underlying their work, and they rank considerably above the average American structural draftsman.

There are many such men in South America, but frequently their place is filled by young Italian, German, Austrian or Scandinavian civil-engineer graduates of the great European universities, who are willing to work for small salaries while learning the language of the country or while "revalidating"* their degrees.

The cost of living is particularly high in Buenos Aires, where American shoes cost $8 to $10 per pair, Stetson hats $10 each, collars $2 per half dozen, etc. A small and uncomfortable room with meager board in the native style will cost $50 to $75 per month. In spite of these excessive expenses, many young Europeans have flocked to Brazil, Uruguay and the Argentine. Often these men have enjoyed excellent educational advantages; yet they are used to much lower salaries and more modest conditions of living than our young men, and hence are willing to work for the small wages mentioned.

Only a few of the foreigners have been able to leave South America to return to their countries since the sea has been closed to merchant steamers. Great numbers will pour into the southern countries at the close of the war. It should be perfectly evident that our draftsmen, clerks and high-grade artisans, with all the national ignorance of and disinclination to learn foreign languages, will be able to offer very little real competition to these men.

The case is not very different for engineering graduates. In the Argentine, for example, as I have shown in my letter in ENGINEERING NEWS, Apr. 30, 1914, p. 979, the cost of "revalidation" is so high, the time so long and the requisite knowledge of Spanish so unusual, that no private practice could ever be obtained. As employees of American companies, engineers are apt to become much dissatisfied with living conditions, unless the salaries paid are very high.

It should, of course, go without saying that it is useless to expect any success in South America unless one speaks Spanish or Portuguese. A large part of the passenger list of every steamer to Rio or the Plate is made up of soi-disant engineers "looking for a job." Most of them return in a sadder and wiser frame of mind after a very short visit. The writer has even seen American mechanics who have journeyed all the way to Buenos Aires "on speculation." He is not speaking of the threshing machine operators who come on contract. When it is realized that in Buenos Aires a 10-hr. day's wage for brick masons is less than $2.50, or for carpenters $2, the utter folly of such "speculation" is seen.

To turn to the more general aspects of the case: South America has no floating capital of its own and does not usually borrow it directly to accomplish public works of great magnitude, preferring rather to grant long-time concessions to foreign capitalists, who naturally purchase all supplies in their own countries. Thus the great port of Rosario was built, and is operated, by a French syndicate. Most of the railways are English. Mineral enterprises are English and American. Many of the electric plants and most of the quebracho forests are German. The meat-packing industry is fast being controlled by Americans. Only in accordance with the amounts that American capitalists are able to invest in other enterprises will engineering work be carried out with American materials.

It is probable that England will keep the seas clear for her enormous commerce, which will continue with but temporary interruptions. With French wines, silks, objets d'art, etc., we do not compete. The opportunity, such as it is, presents itself to us to acquire the trade of Belgium and Germany in metals and manufactured goods. This may, perhaps, last only as long as the war. We are absorbing at present about all that is economically

*"Revalidating" engineering degrees here means practically the process of obtaining a license as Civil Engineer.

possible of South American products, and the general principles of commerce will act to prevent us entirely and permanently supplanting those countries, for they can consume very much more of the South American exports than we.

Our opportunity is for establishing and extending the market for certain articles which we manufacture better, or more cheaply, than the European countries. Many of these are already in the field, and others, such as electrical supplies (in which our present trade is weak), cement, structural materials and small manufactured goods, could secure a decided foothold—only, however, in case our manufacturers will adopt the most modern methods of selling. Let the market be seriously studied as to its likings, demands and possibilities. Spanish-speaking representatives, who have some understanding of the customer's character, must be found. Unfortunately, these are few and far between.

What I have said applies mainly to the East Coast countries. On the West Coast, our commerce and enterprises have been developing for some years in a healthy manner. The opportunity for increases is good, but is strictly limited by a very much smaller population and purchasing power than in the princely East Coast republics.

This letter is written not in pessimism, for many opportunities do now exist for the wise and adaptable manufacturer, but as a warning against over-rashness on the part of adventuresome men, young or old.

CYRUS T. BRADY, JR.

615 Lake St., Elmira, N. Y., Aug. 24, 1914.

## The Waterproofing of the Muskogee Reservoir

SIR: In one of your recent issues, there appeared a full-page advertisement dealing exclusively with the merits of a waterproofing material applied to the interior surface of a 6,000,000-gal. reservoir designed by the writer for the City of Muskogee, Okla. The inference in the advertisement is plain that the waterproofing is wholly responsible for the excellent results secured.

The specifications covering the construction of this reservoir did not contemplate the use of any special waterproofing material. The only waterproofing called for was two coats of neat cement wash to be applied with a whitewash brush on the inside of the basin, the second coat to be applied before the first one had had time to get very hard. The writer is of the opinion that any special waterproofing for such a structure is unnecessary to secure the degree of water-tightness called for in the specifications under which the reservoir was constructed. However, as the contractor was under contract to keep the leakage within the limits of the specifications, he cannot be criticized for taking the additional precaution, entirely at his own expense, of mixing a patent waterproofing ingredient in the cement wash called for under the specifications.

Under ordinary conditions, the writer is opposed to the use of waterproofing ingredients in the concrete or waterproofing applications to the exposed surface. It is far better to put the value of waterproofing materials into the concrete work itself by adding more cement and securing better workmanship. In general, the use of waterproofing ingredients or applications tends to poor construction work, the contractor counting upon the waterproofing to materially help out careless construction. At Muskogee, Okla., the faithful work done by the contractor in mixing and placing the concrete was ample assurance to the writer that the structure when completed would be water-tight within the limits of the specifications.

The writer has designed a number of reinforced-concrete reservoirs in which neither waterproofing ingredients nor applications were counted upon for water-tightness, and in many cases not only a water-tight but a practically damp-proof construction was obtained. That it is possible to obtain with concrete, water-tightness sufficient for all practical purposes is an established fact. In the past two years the writer has constructed four identical sewage pumping stations, three at Harrison, N. Y., and one at Moorestown, N. J., in which the pumping pits are constructed below the ground-water level and subjected to hydrostatic heads ranging from 7 to 10 ft. In three of these pumping stations, a satisfactory damp-proof construction was obtained. In the fourth case, the contractor had considerable trouble from leakage and sweating, which can only be attributed to poor workmanship, and which necessitated the use of a waterproofing application to meet the requirements of the specifications.

In addition to the Agency Hill Reservoir, the writer also designed and constructed for the City of Muskogee, a 6,000,000-gal. reinforced-concrete settling basin in which no waterproofing ingredients or applications were used. The water-tightness of this structure came well within the specifications, which were similar to those for the Agency Hill Reservoir.

ALEXANDER POTTER.

Havana, Cuba, Aug. 20, 1914.

## NOTES AND QUERIES

**A Formula for Columns Subjected to Bending,** given in our issue of Aug. 27, p. 452, by Prof. J. P. J. Williams, contained a slight typographical error. In the final formula for Ac, middle of second column, the denominator should have the figure 1 in place of the letter I. The corrected formula thus reads:

$$A_c = \frac{K}{1 - K\frac{P_b}{s}}$$

A. M. V. A., Chicago, Ill. inquires whether he can collect a claim from an insurance company for the loss of a chest containing a large number of records of work on engineering projects useful for reference, standard drawings, sets of tables and data, reports made in damage suits, etc.

Insurance policies generally contain clauses exempting the company from liabilities for loss of documents. This is necessary for the protection of the company against claims of large amounts based on the value of such documents as notes, stocks, bonds, wills, etc. But such papers as those described by our correspondent which have a value for purposes of reference like the works in an engineer's library, are not to be considered as documents and a reasonable valuation, based on their usefulness as a means of information, should be a valid basis for a claim against the insurance company.

**Pulling Steel Sheet Piling** from coffer-dams after the work is done is not always an easy matter. In some of the bridge foundation work for the Grand Trunk Pacific Ry. along the Fraser River, in British Columbia, the hoisting hook inserted in the hole in the pile would tear through the web, splitting pile to the top. In one case, the metal above the hole crumpled up in solid folds and developed such intense heat that the folds were welded together.

# A Large Sewer Tunnel at St. Louis

A costly piece of sewer work which has been undertaken at St. Louis, Mo., and which involves the unusual feature of working under pressure, is the Mill Creek joint district sewer. Its purpose is to relieve the old Mill Creek sewer, which is now working far beyond its capacity. The new sewer will be at a low level, as shown by the profile, Fig. 1, with drop shafts from several sewers above it. It will take the storm flow of the old sewer by means of a drop shaft near Vandeventer Ave. It will be 20,000 ft. in length, of which 18,200 ft. will be in rock tunnel, with 1800 ft. at the outfall built in open cut. The flow capacity is 3300 cu.ft. per sec.

the method of payment in tax bills, which necessitates the financing of the entire cost by the contractor.

On account of congestion in the main valley, the sewer is laid out along the ridge on the south side. To the east of Theresa St. the territory is built up almost solidly, being in the old part of the city. Core borings with diamond drills were made at frequent intervals, in order to obtain a reliable knowledge of the depth and character of the rock. The tunnel will be driven from a number of shafts, the approximate location of which is shown on the plan.

The tunnel is of horseshoe section, 16½ ft. high and 16½ ft. wide at the springing line. The principal sections in tunnel and in open cut are shown in Fig. 2. For the tunnel, which will have 60 to 90 ft. of rock

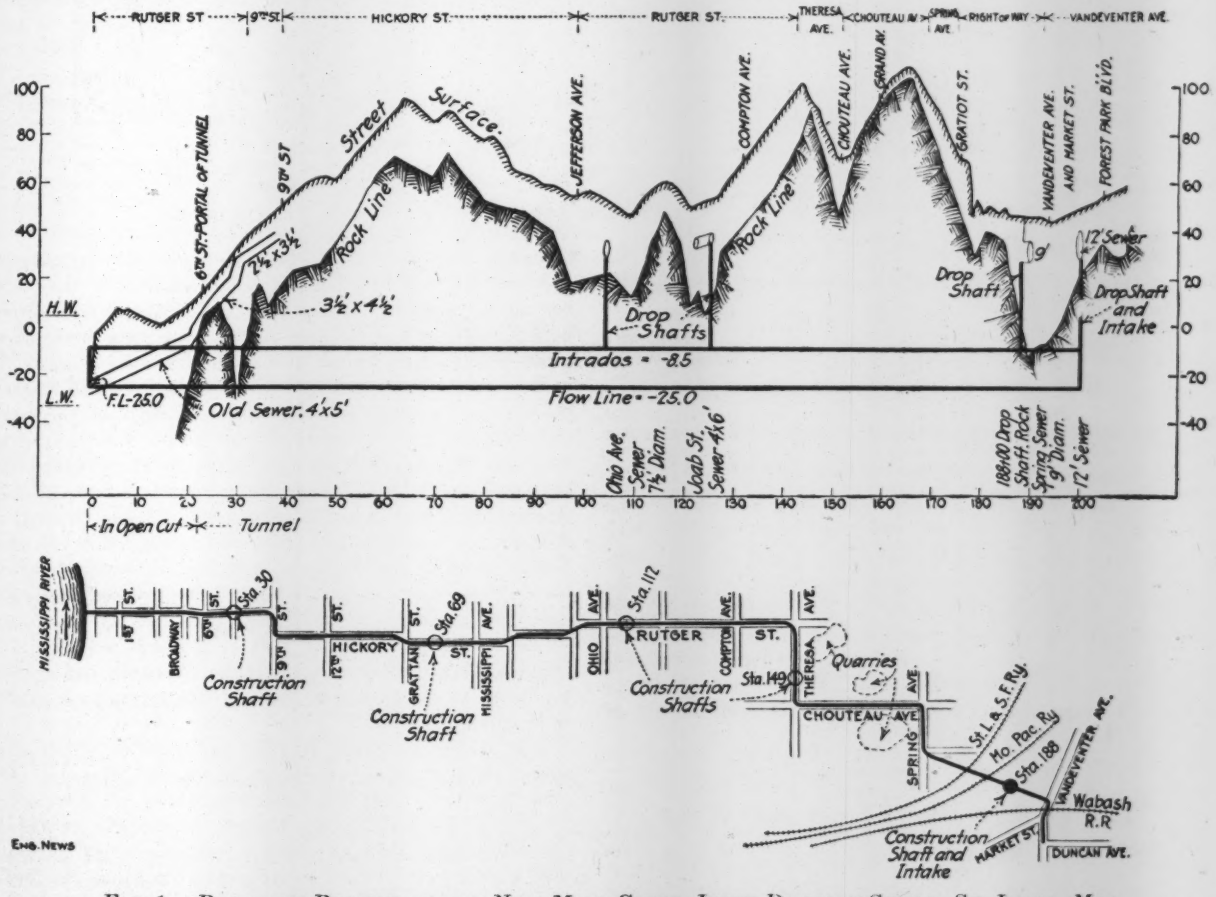
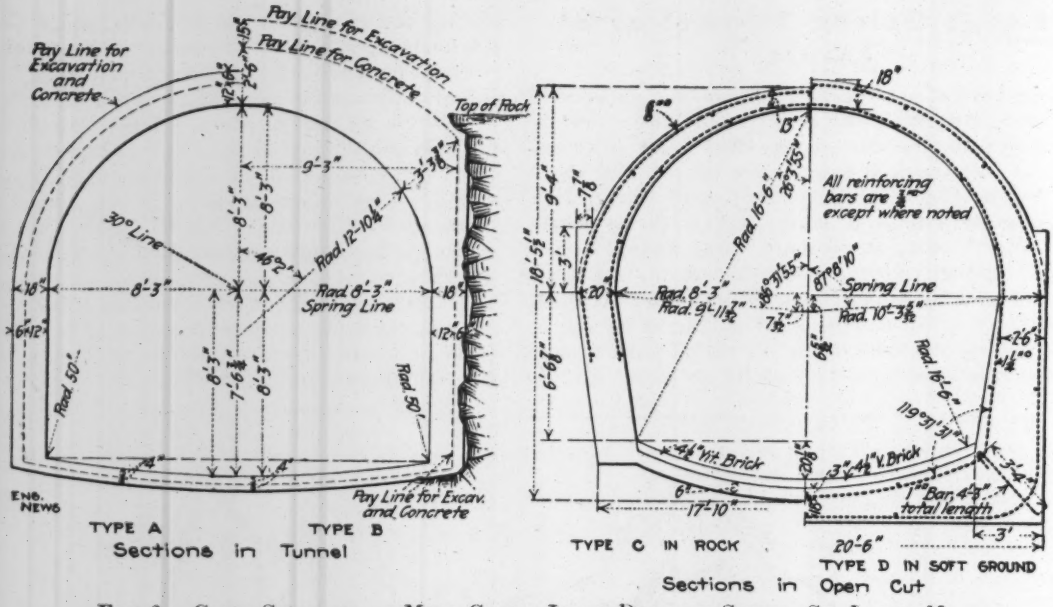



FIG. 1. PLAN AND PROFILE OF THE NEW MILL CREEK JOINT DISTRICT SEWER, ST. LOUIS, MO.

The special features of the work include the following: (1) The design of a sewer as a pressure tunnel in order to construct the tunnel as far as possible through solid rock; (2) the consequent level flow line; (3) diversion chambers with peculiar overflow weirs in order to conduct storm water to the tunnel and ordinary sewage to the old Mill Creek sewer; (4) special drop shafts leading the flow from the diversion chambers in the high-level sewers into the tunnel; (5) the use of granite aggregate in the concrete work of the chambers and drop shafts; (6) the design of the reinforced-concrete section in open cut; (7) protection of the outlet by reinforced-concrete sheet-piling; and (8) most important of all, cover, section (A) is to be used where the line of solid rock is more than 16 ft. above the springing, and section (B) where this line is 7 to 16 ft. above the springing on both sides. For open-cut work, with 25-ft. fill, section (C) is to be used in rock, and section (D) in soft ground. These latter sections will have vitrified brick lining for the invert. The quantities are as follows:

| | Tunnel | | Open cut | |
|---|---|---|---|---|
| | Sec. A | Sec. B | Sec. C | Sec. D |
| Excavation, cu.yd. | 11.74 | 13.39 | 5.39* | .... |
| Concrete (within neat line), cu.yd. | 2.88 | 4.53 | 2.61 | 4.91 |
| Vitrified brick (cu.yd.) | ..... | ..... | 0.21 | 0.21 |
| Steel reinforcing bars, lin.ft. | ..... | ..... | 112,500 | 298,000 |

*Excavation below springing.

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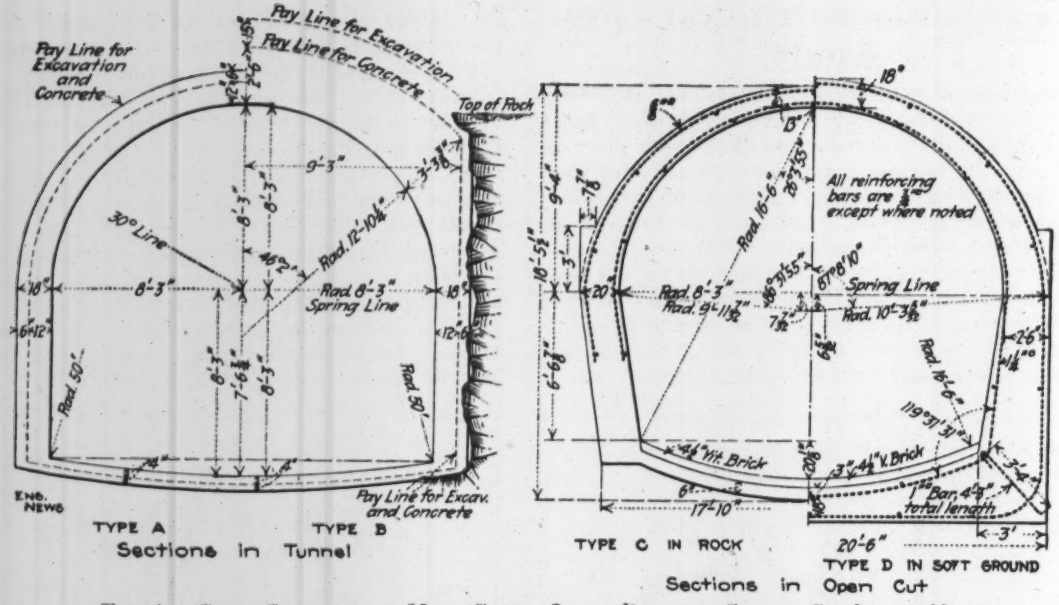


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**The Tai Tam Tuk Reservoir,** now under construction for the water supply of Hongkong, China, will have a storage capacity of 1,800,000,000 U. S. gal. According to a brief note in the "Indian and Eastern Engineer" for July, 1914, the reservoir "is designed to catch the overflow from the Tai Tam proper, and the Tai Tam intermedite reservoirs." Thus far, the construction has proceeded to the extent of diverting streams and making it possible to store 60,000,000 U. S. gal. for use by pumping. The construction work "is being carried out under the supervision of the Public Works Department," and will require five years more for completion.

**The Annual Improvement Work on Missouri Roads** by volunteer laborers took place Aug. 19, 20 and 21. It is stated in newspaper reports that the number of volunteers was less by 50,000 than the number which turned out last year, when the scheme was inaugurated; but this is made a matter of congratulation by stating that many residents of cities turned out last year, who proved to be more ornamental than useful; while this year the volunteers were farmers and country residents capable of doing a day's work. Governor Major spent the whole three days with a gang of 25 convicts. The Governor is optimistic enough to believe the state is a gainer by $1,500,000 as a result of the three days of popular road work.

**Trade of the United States With Other American Countries** in the year ending June 30, 1914, aggregated $1,303,000,000, or 30% of the commerce handled by domestic ports. Of this, 956 million was with North America and 347 million with South America, according to recent statistics of the Department of Commerce, Washington, D. C. Imports from North American countries into the United States, valued at $427,000,000, were chiefly from Canada, Cuba, Mexico, Central America and the British West Indies. Exports to these countries, amounting to $529,000,000, were chiefly to Canada; next come Cuba, Central America and Mexico. Although the trade of the United States is very extensive in North America, this is not the case in South America. In Argentina, Brazil and Chile, for instance, only about 15% of the imports were from this country.

**The Last Spike** on a new railroad was driven at Nova, Ohio, Aug. 17. This event, now rare in the East, marked the completion of the Lorain, Ashland & Southern R.R., 78 miles long. It begins with a belt line at Lorain, on Lake Erie, and runs south to Custaloga, on the Pittsburgh, Fort Wayne & Chicago R.R. (Pennsylvania System). It crosses two branches of the Lake Shore & Michigan Southern, the Wheeling & Lake Erie, the Cleveland, Cincinnati, Chicago & St. Louis, the Northern Ohio, the Baltimore & Ohio and the Erie roads. Most of the line has been built within a year and a half, though the 20-odd miles between the Erie and Pennsylvania Lines (Custaloga and Ashland) has been built 15 years. The road is capitalized for about $4,500,000, or $56,000 per mile. Full schedule operation will begin Sept. 1. Freight will be hauled by steam trains and passengers by storage-battery cars.

**Another Concreting Record at Arrowrock Dam**—The June "Reclamation Record" gave what was believed to be a world's record for concrete placing with 1-yd. mixers, made at the Arrowrock Dam, Boise Project, in April, 1914. The record was broken during May, according to July-August issue of the same journal. The following figures for the two months show that the April record was substantially exceeded in every particular during May:

| | April | May |
|---|---|---|
| Total yardage for the month | 45,700 | 51,490 |
| Number of hours per shift | 8 | 8 |
| Number of shifts per day | 2 | 2 |
| Number of hours per day | 16 | 16 |
| Number of 1-yd. mixers | 3 | 3 |
| Number of mixer hours per day | 48 | 48 |
| Number of working days | 26 | 26 |
| Number of mixer hours | 1,248 | 1,248 |
| Number of mixer hours delay | 165 | 68 |
| Number of mixer hours, delay deducted | 1,083 | 1,180 |
| Average yardage per day | 1,758 | 1,980 |
| Average yardage per 1-yd. mixer per day | 586 | 660 |
| Average yardage per 1-yd. mixer per hour, delays deducted | 42.2 | 43.9 |

**A Remarkable Highway Bridge**—For 16 months, a brick pavement with a concrete foundation on a rural road in Cuyahoga County, Ohio, has bridged a gap 80 ft. long and 7 ft. wide over a washed-out roadbed. The pavement was illustrated in "Engineering News" of Oct. 9, 1913, p. 695. According to the August issue of "Dependable Highways," the new publication of National Paving Brick Manufacturers Association, this same pavement is still in use, with no other safeguards than a few timber props and a guard rail to keep vehicles from venturing over the edge of the projecting shelf. The pavement is near Tinker's Creek, on the Dunham road, where the washout occurred in March, 1913. It is said that after the washout, the road authorities attempted to break up the pavement with sledge hammers, but it resisted so tenaciously that traffic was allowed on it; and the road has been in use ever since. The chief cause of delay in backfilling the road foundation has been a project to divert the road to a new location.

**Iron Ore Output in 1913 Largest**—The crude iron ore mined in the United States in 1913 amounted to about 62 million long tons, compared with 55 million in 1912, an increase of about 12%. The iron ore shipped from the mines in 1913 was about 60 million tons, valued at $131,000,000, compared with about 57 million tons, valued at $107,000,000 in 1912. The average price of ore per ton for the whole country in 1913 was $2.19, compared with $1.88 in 1912. These statistics include the ore used for fluxing other metallic ores at smelters in the Middle and Western States, but do not include the iron ore sold for the manufacture of paint. The latter ore in 1913 amounted to about 17,000 tons, valued at $45,000.

Iron ore was mined in 28 states in 1913; the five largest producers were; Minnesota, Michigan, Alabama, New York and Wisconsin. The output of the Minnesota iron ranges amounted to five-eighths of the total. The Lake Superior district, comprising all the mines in Minnesota and Michigan and those in northern Wisconsin, mined 84.5% of the total.

**A Report on the Reservoir Break** at Turlock, Calif., described in "Engineering News," July 9, 1914, has been made by a committee of the affiliated commercial organizations of this irrigation district, confirming the probable causes set forth before. The report states (1) that the water forced its way through the south wing of the outlet gate on account of poor workmanship, (2) that the break was due to faulty filling behind the concrete bank lining, (3) that the fills along the north side of the Davis reservoir are faulty and porous, (4) that abnormal and alarming flows preceded the break but that the operating officials did not heed the warning. It is also reported (5) that the gate proper is undamaged, and (6) that there is good material available for an impervious earth fill. The committee recommends (1) strengthening all present fills "under the advice and immediate supervision of a first-class experienced engineer," and (2) appointing a general manager and superintendent for the district of "acknowledged ability and experience," to have control and supervision of the entire irrigation system, of the employing and discharging of employees, of the purchasing of supplies and auditing of bills. Several of the district directors have resigned.

**An Ocean Car Ferry Steamer** for through freight service between the United States and Cuba is being built for the Florida East Coast Ry. by the William Cramp & Sons Ship & Engine Building Co., at Philadelphia. It will run between Key West and Havana. It resembles the car-ferry steamers operating on Lake Michigan, having the bow and sides carried up to a deck over the track deck, so as to give a high freeboard in rough weather, while the stern is open for the passage of cars. The stern end of the track deck is shaped to fit the recessed end of the landing pier, so as to adjust the boat and shore tracks in proper line. The boat was designed originally to be 410 ft. long, carrying 36 cars, but as built it is 350 ft. long and has capacity for 30 cars. It is 57 ft. wide and 22 ft. deep, and has a speed of 12 knots with 2300 tons cargo load. There are four tracks, and when the cars are in place their bodies are supported by jacks, so that they cannot swing on the truck springs when the vessel is rolling. The double bottom has tanks for feed water and for water ballast when the vessel is light. There are also two tanks for carrying molasses, with pump equipment for handling this cargo.

The machinery consists of two triple-expansion engines, developing 3000 hp. at 100 r.p.m., and steam is supplied by Scotch marine boilers. Special arrangements are made for fitting guns to adapt the boat to naval or transport service. The officers' and crew's quarters are in superstructure on the upper deck. The boat is nearly ready for launching and will be named the "Henry M. Flagler," after the late president of the railway, who originated the idea of the Key West extension (with its ocean viaduct) and the Cuba car ferry.

**Proposed Municipal Water-Works for Birmingham, Ala.,** were reported upon by Julian Kendrick, City Engineer, on Aug. 17. This report is printed in full in the Birmingham "Age-Herald" of Aug. 18, from which we have taken the following: Mr. Kendrick reports that a municipal plant can be built on the Coosa River, where there is enough water to supply a city several times the size of Birmingham. The

site of the proposed pumping plant is at Glover Ferry between the proposed location of Locks 7 and 8, near the point where the Atlanta, Birmingham & Atlantic R.R. crosses the river. From the pumping plant a 48-in. force main is designed to be laid by way of Sterretts, passing through Coosa and Oak Mountains by means of tunnels, to a reservoir and filter site, near East Irondale, thence to the city's distribution system. The pumping plant will consist of one 12,000,000-gal. and two 8,000,00-gal. pumping engines—a total pumping capacity of 28,000,000 gal. per day. The pumps will operate against a head of 460 ft. The force main will be 117,600 ft., or 22.3 miles long.

Two storage reservoirs are planned at Slades Mountain with a total capacity of 300,000,000 gal. at an elevation of 800, or 35 ft. above the surface of the distributing reservoirs of the Birmingham Water Works Co. The proposed filter plant is designed to take 26,000,000 gal. per day. From the filter plant to the city's distribution mains, 32,000 ft. of 48-in. main will be required, and it is planned to spend about $1,500,000 on the distribution system. The estimated cost of the whole is approximately $4,500,000.

Under the present contract with the Birmingham Water Works Co., the city is required to pay 15c. per 1000 gal. for water, $55 per year for each fire hydrant, and the rate to private consumers ranges from 8c. to 30c. per 1000 gal. Mr. Kendrick reports that the city can sell water from the proposed plant for 10c. per 1000 gal. at a net profit of $52,560 per annum.

**Temperatures of Ingots and Rails in Rail Rolling** were measured by the Bureau of Standards at four rolling mills recently. The purpose was to determine prevailing practice regarding rail-rolling temperatures, find out what the shrinkage clause in rail specifications amounts to and determine if possible what parallel there is between physical properties of rails and rolling temperatures.

There is practical uniformity among the several mills for the rolling temperatures of ingots for steel rails, the range being from 1975° F. to 2085° F. There is no very considerable difference among the finishing temperatures of the rails at the hot saws, the range being about 1615° F. to 1815° F. the average, 1715° F.. is 520° above the critical range of rail steel. Chemical analyses and micrographic examinations, together with tests of the chemical properties from samples of the rail whose tempertures have been observed, showed no particular relation between these various factors and the rolling temperatures.

The observations covered both openhearth and bessemer steel, the former having 0.65 to 0.70% carbon, and the latter 0.40 to 0.50% carbon. The melting points of the steel range from about 2680° F. to nearly the melting point of iron at 2786°. The critical point of the steel on heating was about 1350°, and on cooling —about 1230°.

The doefficient of expansion for openhearth and bessemer steel was found to be different. Between 0 and 1800° F. the linear coefficient per degree Fahrenheit was 0.0000081 for bessemer, and 0.0000087 to 89 for openhearth. On this basis the shrinkage allowance of 6¾ in. in 33 ft. fixed by the American Society for Testing Materials in 1909 specifications allows temperatures of 1947° F. to 2055° F., which is very far above the critical range of the steel. Thus the specification, the Bureau points out, does not serve its avowed purpose of limiting the finishing temperature to a value slightly above the critical range.

## PERSONALS

Mr. J. W. Barrie, Principal Assistant Engineer of the Florida East Coast Ry., has resigned, and the office has been abolished.

Dr. George F. Swain, Past-President of the American Society of Civil Engineers, of Harvard University, was married on Aug. 21 to Mrs. Mary Augusta Rand, daughter of Mrs. George W. Batchelder, of Ipswich, Mass.

Mr. Fred. W. Lepper, M. Am. Soc. C. E., recently Supervisor of Construction of the building of the Bureau of Engraving and Printing, Washington, D. C., has been transferred to Augusta, Ga., to supervise the construction of the new Post Office building.

Mr. H. A. Butz, for the past four years Chief Engineer of the Dominion Iron & Steel Co., Ltd., Sydney, Nova Scotia, has resigned. The company has discontinued all construction work for an indefinite period, due to present war conditions. Mr. Butz was formerly with the Garrett-Cromwell Engineering Co., Cleveland, Ohio.

Mr. Morgan K. Barnum, recently General Mechanical Inspector of the Baltimore & Ohio R.R., has been promoted to be Superintendent of Motive Power, with headquarters at Baltimore. He is a graduate of Syracuse University, class of 1884, and began his railway experience as a special apprentice in the shops of the New York, Lake Erie & Western R.R. at Susquehanna, Penn.

Mr. Hale Holden, Vice-President of the Chicago, Burlington & Quincy R.R., has been elected President to succeed the late Darius Miller, whose death was noted in our issue of last week. Mr. Holden was born in Kansas City, Mo., in 1869, and is a graduate of Williams College and Harvard Law School. His railway service began in 1907, and from 1910 to 1912 he was General Attorney of the Chicago, Burlington & Quincy R.R.

Mr. Ant. Decarie, Chief Inspector of the sewer department, northern division, Montreal, Que., and three of his Assistant Inspectors have been dismissed for alleged incompetency and irregularity in connection with the construction of the Notre Dame de Grace sewer. The dismissal of Mr. E. Pelland, Engineer in charge of the sewer department, for alleged graft in connection with the construction of this sewer, was noted in our issue of July 23, 1914.

## OBITUARY

T. C. Chase, former Building Inspector of Denver, Colo., and for the past seven years connected with the construction department of the Denver Union Water Co., died Aug. 21. He went to Denver in 1879 from Massachusetts.

Edgar Thaddeus Welles, Vice-President of the Wabash R.R., died Aug. 22, at his home in New York City. He was born in Hartford, Conn., Aug. 29, 1843, and was the son of Gideon Welles, Secretary of the Navy under President Lincoln.

William E. Harwig, Supervisor of Bridges and Buildings of the Lehigh & New England R.R., died Aug. 24, at his home in Phillipsburg, N. J. He entered the service of the Lehigh Valley R.R. in 1878, and for 10 years, 1902 to 1912, was Supervisor of Bridges and Buildings.

Bernhardt W. Pohler, for 24 years an engineer with the American Bridge Co., died July 27. He was born in Denmark, Mar. 10, 1858, and graduated from the Royal College of Denmark in 1884. He is survived by a widow, whose present home is 4440 Dover St., Chicago, Ill.

Charles F. Baker, until about six months ago Mechanical Engineer of the Bay State Street Ry., Boston, Mass., died recently in East Orange, N. J. He was born in Vermont 59 years ago. In 1893 he was Master Mechanic of the West End Street Ry., Boston, Mass., and was later with the Boston Elevated Ry. as Superintendent of Motive Power and Equipment. In 1904 he was President of the American Electric Railway Association.

Roderick J. McD. Parke, Assoc. M. Can. Soc. C. E., Consulting Engineer, of Toronto, Ont., died Aug. 25, at his home in that city. Mr. Parke was the designer of one of the first long-distance electric transmission lines in Canada, that from Ragged Rapids, on the Severn River, to Orillia. He also designed light and power plants for numerous towns in Ontario. As Consulting Engineer for the Canadian Government, he had charge of the design of the lighting equipment of the Welland Canal.

Berthold Charles Kaiserling, recently with the city engineering department of San Antonio, Tex., was accidentally killed July 5, by a passenger train of the Southern Pacific Ry, at Galveston, Tex. Mr. Kaiserling was a civil engineer of vide experience in Mexico and South America, and he had just left the employ of the city of San Antonio to accept a position in South America. He had been with the engineering corps of the Mexican Central Ry. and of the Guayaquil & Quinto R.R. in Ecuador. At one time he was in charge of harbor work at Vera Cruz, Mex. He had also seen service in Guatemala. Mr. Kaiserling is survived by a widow, whose home is 113 Oak St., San Antonio, Tex.

William de Hertburn Washington, M. Am. Soc. C. E., Consulting Engineer, New York City, died Aug. 30, at the New York Hospital, from cerebro-spinal meningitis, after an illness of three days. He was born in Baltimore, Md., June 29, 1868, and traced his descent to John A. Washington, a brother of George Washington, of Mount Vernon, Va. He was for a time in the consular service in Canada. About 20 years ago, he came to New York City and for several years was President of the Hydraulic Construction Co. Later he was in the real estate business. Of recent years, he has been

quite widely known as a consulting engineer on highways, and served as a member of the board of engineers which a short time ago investigated New York State highway work. He was unmarried.

Prof. Adolf Martens died on July 24, 1914, at 64 years of age. For 30 years he had been Director of the Royal Prussian testing laboratory, first at Charlottenburg, and since 1904 at Gross-Lichterfelde. Raising this institution to undisputed leadership among testing laboratories was Martens' great work. His name will be longer remembered, however, by his metallographic work (martensite, the chief constituent of hardened steel, is named after him), by his endurance tests of metals (part of them still running), by his designing many original and improved instruments and machines for testing (the mirror extensometer and the diaphragm pressure-gage are among the best known), and by his efforts to make mechanical testing a scientifically reliable operation. In the latter regard he stood virtually alone, yet he accomplished enough to leave a long enduring impress on the testing world. Among other writings, he published an authoritative work on materials, which has been translated into English. He was one of the active spirits of the International Association for Testing Materials; his visit to America at the 1912 congress of that body in New York is doubtless remembered by many American engineers.

## ENGINEERING SOCIETIES

COMING MEETINGS

AMERICAN MINE SAFETY ASSOCIATION.
Sept. 7-10. Annual meeting in New York City. Secy., H. M. Wilson, Bureau of Mines, Pittsburgh, Penn.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
Sept. 7-11. Annual meeting at Chicago, Ill. Secy., A. P. Backert, Cleveland, Ohio.

NATIONAL PAVING BRICK MANUFACTURERS' ASSOCIATION.
Sept. 9-11. Annual convention at Buffalo, N. Y. Secy., Will P. Blair, 832 B. of L. E. building, Cleveland, Ohio.

NATIONAL ASSOCIATION OF PORT AUTHORITIES.
Sept. 8-10. Annual convention in Baltimore, Md. Secy., Wm. Joshua Barney, 29 Broadway, New York City.

ROADMASTERS AND MAINTENANCE OF WAY ASSOCIATION OF AMERICA.
Sept. 8-11. Annual meeting at Chicago, Ill. Secy., L. C. Ryan, Sterling, Ill.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 8-11. Annual convention in Nashville, Tenn. Secy., A. P. Dane, Reading, Mass.

NEW ENGLAND WATER-WORKS ASSOCIATION.
Sept. 9-11. Annual convention in Boston, Mass. Secy., Willard Kent, Narragansett Pier, R. I.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Sept. 15-18. Convention in Atlantic City, N. J. Secy., Clayton W. Pike, Electrical Bureau, Philadelphia, Penn.

ILLUMINATING ENGINEERING SOCIETY.
Sept. 21-25. Annual convention in Cleveland, Ohio. Secy., Joseph D. Israel, 29 W. 39th St., New York City.

RAILWAY SIGNAL ASSOCIATION.
Sept. 22-24. Annual convention in Bluff Point, N. Y. Secy., C. C. Rosenberg, Times Building, Bethlehem, Penn.

ATLANTIC DEEPER WATERWAYS ASSOCIATION.
Sept. 22-26. Annual convention at New York. Secy., Addison Burke, Philadelphia, Penn.

INTERNATIONAL IRRIGATION CONGRESS.
Oct. 5-9. At Calgary, Alta. Secy., Andrew Miller, Industrial Commissioner, Calgary.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 12-16. Annual convention at Atlantic City, N. J. Secy., E. B. Burritt, 29 West 39th St., New York City.

NATIONAL COUNCIL FOR INDUSTRIAL SAFETY.
Oct. 13-15. Annual "Safety Congress," at Chicago, Ill. Secy., W. H. Cameron, Continental Bank Building, Chicago.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 20. Convention at Los Angeles, Calif. Secy., C. A. Lichty, 319 North Waller Ave., Chicago, Ill.

**Kansas League of Municipalities**—The League, which embraces 120 Kansas cities, will meet in Lawrence, Oct. 7-9, to discuss the beautifying of cities, and problems in city engineering and sanitation.

**Central Railway Club**—The most important paper to be presented at the next annual meeting and outing to be held at Buffalo, N. Y., Sept. 11, is on "Locomotive Arch Brick," by George Wagstaff, American Arch Co., New York City. The Secretary of the Club is Harry D. Vought, 95 Liberty St., New York City.

**Upper Mississippi River Improvement Association**—The 13th annual convention will be held at Stillwater, Minn., Sept. 16-7. Inviations have been sent to the Governors of Iowa, Missouri, Minnesota and Wisconsin, to the Mayors of all municipalities in the Upper Mississippi Valley, and to kindred waterway associations. The Secretary is L. B. Boswell, Quincy, Iowa.

**American Electric Railway Association**—The annual convention of this Association and its affiliated bodies, the American Electric Railway Accountants, Engineering, Claims, and Transportation and Traffic, Associations, will be held in Atlantic City, Oct. 12-16, at Young's Million Dollar Pier. At the same time, the American Electric Railway Manufacturers' Association will hold an exhibit of electric-railway appliances. The secretary is E. B. Burritt, 29 West 39th St., New York City.

**The American Boiler Manufacturers' Association**—The program for the 26th Annual Convention of the Association, to be held in New York City, Sept. 1-4, has been arranged as follows: Addresses of welcome will be delivered by Hon. Henry Bruere, City Chamberlain, and Charles R. Lamb, a director of the Merchants' Association of New York. The business session will be held that afternoon, and in the evening the reception at the Waldorf-Astoria. At other sessions the following committees will report: Uniform Specifications, Uniform Boiler Laws and Uniform System of Cost Keeping, and Topical Questions. The banquet will be held on the evening of Sept. 3.

**National Council for Industrial Safety**—The third annual "Safety Congress" will be held at the La Salle Hotel, Chicago, Oct. 13 to 15. There will be addresses, reports of committees, papers, moving-picture displays, and also an exhibit of safety devices and methods. Different sessions will be devoted to government work, the economics of safety, industrial hygiene, safety in transportation and public service, and safety in manufacture.

According to the advance report of the secretary, the Council established its headquarters in Chicago in October, 1913. It has now 731 member companies or firms, with 2155 representatives in the council, having about 750,000 employees. One of the principal activities of the organization is in the distribution of bulletins for statistics and other information relative to the safety movement. President, R. W. Campbell, Illinois Steel Co., Chicago. Secretary, W. H. Cameron, Continental and Commercial Bank Building, Chicago.

**Central States Water-Works Association**—The 18th annual convention was held at the Windsor Hotel, Wheeling, W. Va., Aug. 25 to 27, inclusive. The address of President J. C. Martin, of Wilmington, Ohio, covered briefly the history of the association and the problems which were coming before it and its members in the increasing density of population and the contamination of streams. F. W. Collins, Superintendent of the Water Department of Manistee, Mich., described the working of a commission plant city government in Manistee, which has a population of about 12,000, where it has evidently been an unqualified success. C. B. Cooke, City Engineer of Wheeling, described various methods used to filter and treat Ohio River water by the cities which are obliged to use it for potable water supplies. The paper consisted chiefly in elementary principles of water purification. He stated that "Wheeling had been criminally negligent in regard to water purification, and that the typhoid fever death rate for the ten years ending in 1913 was 80 per 100,000 per annum." In July, the city voted for a filter plant, and the city engineering staff are now working on plans and surveys. The system of water purification which received a preferential vote of the people last July is the "Smith System," invented by L. E. Smith, of Charleston, W. Va., and was described by him in a paper on the filtration and purification of the Ohio River water. Mr. Smith described the method by referring to the plant now in operation at Parkersburg, W. Va., as the best example, which has been in operation for three years. This plant consists of 160 strainer pipes, sunk in the bed of the river; these strainers are joined to collector pipes leading to pump wells on shore. The water is filtered by the natural sand and gravel bed of the river itself. For washing the filter bed if it becomes polluted, water may be forced back through collector pipes and strainers. The method adopted by the city of Wheeling in referring the type of water purification plant to be built to a popular vote was severely criticized by Dr. S. L. Jepson, Secretary of the West Virginia State Board of Health. On the afternoon of Aug. 27, an excursion was made to the Wheeling city water-works. The place selected for the next convention is Cincinnati, Ohio. The following officers were elected: President, F. W. Collins, Manistee, Mich.; Vice-President, W. C. Davisson, Charleston, W. Va.; Secretary, R. P. Bricker, Shelby, Ohio; Treasurer, A. W. Inman, Massillon, Ohio.